SCIENCE

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REMINISCENCES OF THE WOODS HOLE LABORATORY OF THE BUREAU OF FISHERIES, 1882–89[1]

ON February 9, 1871, a law was passed by Congress which directed the President to appoint a man of approved scientific and practical knowledge of fish and fisheries, to be chosen from among the civil officers of the government, who was to serve as U. S. Commissioner of Fish and Fisheries without additional salary.

This act virtually defined Spencer F. Baird, secretary of the Smithsonian Institution, who thereupon was appointed commissioner by the President. The commissioner was clothed with unusual powers; for the act instructed the heads of the various executive departments to render the commissioner such assistance as might lie in their power. Frequent acknowledgments of the cooperation of the departments of the treasury, war, interior and navy are found in the earlier reports of the Fish Commission.

The immediate problem before the commissioner was: An inquiry into the decrease of food fishes. It is interesting to note that Professor Baird chose Woods Hole as the place for beginning research on this problem. That was in the summer of 1871. Those associated with him were Professors A. E. Verrill, Theodore N. Gill and Sydney I. Smith.

The headquarters in 1872 were at Eastport, Maine; in 1873 at Portland, Maine; in 1874 at Noank, Connecticut; in 1875 again at Woods Hole. During the year

[1] A lecture delivered before the Marine Biological Laboratory, Woods Hole, Mass., August 7, 1914.

1876 no active field operations were carried on by Professor Baird on account of duties connected with the superintendency of the government exhibit at Philadelphia. In the report for 1876, however, the following statement is made:

The laboratory at Woods Hole was opened . . . for investigators, to whom every facility and assistance was furnished by Vinal N. Edwards in charge of the station.

The first part of the summer of 1877 was spent at Salem, Mass. In August the party proceeded to Halifax, N. S., where a second station for the summer was formed. Among the assistants of Professor Verrill that year was E. B. Wilson. (It is needless to inform this audience that E. B. Wilson has since been promoted.) In 1878 the laboratory was on Fort Hill at the mouth of Gloucester Harbor; in 1879 at Provincetown, Mass., and in 1880 at Newport, R. I. In 1881 Woods Hole was again chosen as the center of scientific operations. In the report for that year Professor Baird speaks of the advantages of the place as a permanent sea-coast station of the U. S. Fish Commission. In the report for 1882 the reasons for choosing Woods Hole as a permanent station are given. After speaking of the experience at Gloucester the report continues:

A totally different condition of things was found at Woods Hole where the water is exceptionally pure and free from sediment, and where a strong tide rushing through the Woods Hole passage keeps the water in a state of healthy oxygenation specially favorable for biological research of every kind and description. The entire absence of sewage owing to the remoteness of large towns, as well as the absence of large rivers tending to reduce the salinity of the water, constituted a strong argument in its favor, and this station was finally fixed upon for the purpose in question.

In the report for 1875, published in 1878, one finds the spelling of the name of the station changed from Woods Hole to Woods Holl. This change was made in conformity with a similar change made by the Post Office Department. An ingenious argument for this unusual way of spelling hole will be found in a small pamphlet written by the late Joseph Fay. It should be stated, in justice to the author of the pamphlet, that his contention was that the word in question was really the Norwegian word *holl,* meaning a hill, but pronounced hole.

In this connection it is proper to mention the fact that this same Joseph Fay gave to the U. S. government the waterfront extending from what is now the property of the Marine Biological Laboratory to what is now called Penzance, but then was without a name, if one will except the obvious epithets which were liberally applied to the locality by the residents of Great Harbor whenever the wind was from the northwest, for there was situated a large fertilizer establishment, known locally as the "Guano Works." Among material collected at Woods Hole in 1882, I still have a considerable number of goose-barnacles which I scraped from an Italian bark, 90 days out from the Mediterranean, then tied up at the wharf of the "Guano Works" and unlading her cargo of sulphur.

Prior to 1877 the tug *Blue Light* was detailed by the Navy for the use of the Fish Commission. A larger tug, the *Speedwell,* was detailed in 1877. In the year 1880 the *Fish Hawk,* which had just been built, was used in exploring the Gulf Stream and its fauna, especially in connection with the distribution of the tile-fish. In 1883 the *Albatross,* a ship especially designed for deep-sea work, was completed and placed in commission.

Professor Baird early inaugurated the policy of naming a vessel that was propelled by its own power for some bird. A sailing-vessel was given the name of a water mammal, while rowboats were given the names

of fish. With the installation of auxiliary motors in such craft as the *Grampus* and *Dolphin* the taxonomy of the Fish Commission's flotilla is not without its difficulties.

When Professor Baird was laying his plans for a permanent laboratory he was in much doubt as to his ability to induce Congress to make an appropriation for such purpose. Assured of a location for the laboratory, through the public spirit of Joseph Fay, he conceived the idea of having universities and colleges cooperate in the building of a laboratory. To this end he prepared articles of agreement whereby an institution by contributing the sum of one thousand dollars would have the right in perpetuity to the use of a table in the laboratory. This offer was open for but a short time, as Congress, having had experimental proof of the administrative ability and probity of Professor Baird, made the necessary appropriation for the construction of the laboratory. Before the offer was withdrawn, Professor Alexander Agassiz had subscribed for a number of tables, four, I think, for the use of Harvard University. My recollection is that one table was subscribed for by Princeton, one by Williams, and one by some other institution. It is largely owing to this plan that a succession of graduate students has occupied tables in the laboratory of the Fish Commission since 1885. These students brought with them new ideas and methods and inspiration that have been important factors in the usefulness of the laboratory.

Upon the death of Professor Baird, in 1887, G. Brown Goode was made commissioner pro tempore. He, indeed, was the logical successor of Professor Baird, but preferred to remain at the head of the National Museum. In the meantime the law had been changed, so far as to make the office of commissioner a salaried office. Colonel Marshall McDonald was appointed commissioner in 1888. He served until his death in 1895. Captain J. J. Brice of the Navy was made commissioner in 1896, Mr. Herbert A. Gill being acting commissioner in the interval. Captain Brice served until 1898, when he was succeeded by George M. Bowers, who served for nearly as long a term as that of Professor Baird's. During Mr. Bowers's term of office the commission ceased to be independent. It became a bureau, first in the Department of Commerce and Labor, then in the Department of Commerce. In 1913 Dr. Hugh M. Smith, long associated with the commission, and for some years deputy commissioner, succeeded Commissioner Bowers, and is the present commissioner.

In all the time from 1871 to the present, with the exception of the brief administration of Captain Brice, every encouragement has been given to scientific investigation at the Woods Hole Laboratory of the Fish Commission. Of the laboratory during the administration of Captain Brice I have no personal knowledge. I have been informed, however, that then, for a time, at least, scientific work was virtually suspended, and would have ceased entirely but for the vigorous insistence of Professor Alexander Agassiz on the right of Harvard University to occupy tables in the laboratory. Thanks, therefore, to these compacts, which, I think, Professor Baird somewhat regretted had been entered into, the work of scientific investigation at the Woods Hole Laboratory of the Fish Commission has not been seriously interrupted from its inception under Professor Baird to the present time.

Prior to 1885 the laboratory was on the lighthouse wharf on Little Harbor in the two-story building which had been refitted, the second story added, with outside stairs on the north side. Professor Baird lived in the house which stands just east of the one occupied by Miss Sarah Fay. As I re-

member the house then it had a good-sized porch in front. The offices of the clerical force of the commission were in a house known as the Gardiner house, which stood about where the entrance to the rose garden now is. This house has since been removed. The house occupied by Professor Baird also accommodated the mess, which was made up of the scientific workers and the clerical force. The various members of the party roomed at private houses in the village. For example, in the summers of 1882, 1883 and a part of 1884, four of us younger men had rooms on the third floor of what was then, and still is, the rectory. From the windows of these rooms are to be had some of the most charming views of these beautiful shores.

The residence building was first occupied early in August, 1884. It then accommodated Professor Baird's family, the scientific staff and the office force. The dining-room easily accommodated the entire company, about 30, which constituted a real family, of which Professor Baird was the head. He and his wife and daughter, and some of the older members of the scientific corps, with their wives, occupied one table, the other scientific workers filled another table, and the clerical force a third. The parlor of the residence made a general meeting-place where all the members of the family were accustomed to assemble in the evenings. Although the habit of working in the laboratory at night still continued, members of the laboratory force were in frequent attendance at these family gatherings. In the summer of 1886 we rented a piano and installed it in the parlor, where some pleasant hours were spent in singing, and, on a few occasions, others were invited in and there was a little dancing.

Work on the new laboratory building was in progress during the summer of 1884. A picture which hangs on the south wall of the porch room of the residence gives a view of the locality where the Fish Commission buildings now stand, as it appeared in 1882. During the dredging operations that preceded the construction of the sea wall that encloses the basins we were frequently detailed to make collections of the mud-inhabiting forms that were brought up by the dredge.

The laboratory in 1882 was, as has been stated, on the lighthouse wharf on Little Harbor. Ordinarily the day's work began before 9 o'clock and continued until 10 or 11 o'clock at night. As Professor Verrill's assistant my work in 1882 and 1883 was especially directed to the group of Annelids. Later I was promoted to investigate the ancient and, to some minds, dishonorable, order of Cestodes and their kindred.

In those years there was not much systematic collecting done along shore and in shallow water, except for certain groups and localities. A good deal of time was taken up in the collection and study of surface material, but the chief interest centered about the trips of the *Fish Hawk* to the Gulf Stream. There were other shorter trips for the purpose of exploring some shallow-water localities that were very full of interest to a beginner. The first trip which I made was one to the northward where the dredging operations began off Chatham and continued to Provincetown. It was on this trip that I saw for the first time, in a living state, some particularly large sea-anemones, and the many-armed serpent-star *Astrophyton*. At Provincetown there was at that time an establishment on the point where whale oil was tried out, the whales being taken offshore and brought in to the try-works. There was a vast accumulation of vertebræ, ribs and baleen there, and the younger members of the party took advantage of the opportunity to make private collections, which Captain

Tanner very kindly allowed us to bring back on the ship. The odor thus transferred to the hold of the *Fish Hawk,* while in itself not small, we could assure the captain would not be missed on the point, where it was massive, corporeal and all-pervading.

Almost daily collections were made of surface material. Trips for this purpose were made in the Fish Commission launch, *Cygnet,* D. H. Cleveland, captain, and W. H. Lynch, engineer. Now and then when trips were in the daytime we contrived to have a race with the Forbes launch, *Coryell,* at which times, if the energy with which Lynch shoveled coal could have been transferred directly to the machinery that actuated our propeller, we should have easily won. As it was, unless my memory is at fault, the *Coryell* usually got the better of us.

Two or three times a week collections were made in the evening, beginning just after dark. A favorite place for making these evening collections was in the "hole," where the launch would be made fast to the nun buoy, and for an hour or more towing-nets were used. The material thus collected was then taken back to the laboratory, where it was immediately examined. In this way much information was obtained of the nature, times, seasons, stages of development and habits of the life at and near the surface. I do not remember hearing in those years the word plankton used. Possibly a more tolerant interest might be awakened in a modern audience in these old-time investigations if this paragraph had been headed with the cabalistic legend: Plankton studies.

In 1882 dredging on the outer continental slope was still being vigorously carried on, most of it in depths ranging from 100 to 400 fathoms. Trips to this locality were usually called Gulf Stream trips. The great abundance of living things brought up by the trawl from this under-sea edge of the continent was still yielding many new and interesting forms, and, since it was important that the material be cared for promptly, three or four of the younger men were always detailed for this work. Professor Verrill himself did not go on these trips, the motion of the ship quickly incapacitating him for work. Indeed, any one who can endure the motion of the *Fish Hawk* for 24 hours without experiencing unpleasant sensations can qualify as an able seaman, at least as far as immunity from sea-sickness goes. Our trips to the Gulf Stream were carried out in this wise: The precise time of departure was not set until a short time before starting. This was because the *Fish Hawk,* having been designed as a kind of wandering fish hatchery whose field of operation was to be limited largely to such bodies of water as Chesapeake Bay, was not then and is not now regarded as a vessel that could safely weather a severe storm. It was Professor Baird's custom, therefore, before sending the *Fish Hawk* on an outside trip, to get a special bulletin from the weather bureau saying that no atmospheric disturbances were indicated for the North Atlantic coast for the next forty-eight hours. Favorable conditions prevailing, we were then notified, sometimes but an hour or two, or even less, before starting, that we were expected to make a trip to the Gulf Stream. The usual time for starting was 5 P.M. We steamed out all night, and upon the following morning, having now arrived at the outer slope, began dredging. As a rule the trawl was overboard by 5 o'clock; the first haul was consequently made before breakfast. My recollection of these days are of hours of not altogether unalloyed pleasure. To this day the smell of material brought fresh from the bottom of the sea awakes memories that

I would fain let slumber. The material which but a short time before had been on the bottom at a temperature but little above the freezing point was unpleasantly cold to handle. Then there was the ever-present discomfort caused by the rolling of the vessel, accentuated to a stomach-racking degree by the motion communicated to the vessel when the dredging was in operation. Under such conditions it should not be a matter of wonder if from time to time the most zealous of naturalists turned away from the large seive, into which the material from the trawl was emptied, with feelings akin to those experienced by the fishes just before they lost consciousness as they were being hurried from the bottom. These fishes came to the surface with either swim-bladder or stomach protruding from their mouths, and their eyes starting from their sockets. Such phenomena are due to the enormous release of pressure experienced in being in a few minutes transferred from the bottom to the surface, a difference approximating 50 pounds for each one hundred feet, or 300 pounds per square inch for a depth of one hundred fathoms.

The forms brought from the bottom on the borders of the Gulf Stream, were so varied and so different from those found along shore or at moderate depths that, until they had been seen repeatedly, they caused the disturbing motions of the *Fish Hawk* for the time to be forgotten. For example, an annelid which lives in a tube constructed from its own bodily secretions early attracted my attention. The tube had the appearance of quill; when burned it gave the same odor as burning quill, and, when cut into the shape of a pen, could be used for writing the worm's name. Another was an interesting case of symbiosis, or life-partnership, that had been made familiar to those of us who had listened to Professor Verrill's lectures. Here it was seen in the living condition, a hermit crab having its home in a living house, that grew as the crab grew, and consisting of a colony of sea-anemones. Close examination would usually show that the sea-anemones had originally established themselves on the shell of a mollusk in which the hermit crab was living. The cœnosarc common to the anemone colony not only grew entirely over the shell, but continued the lip of the shell with enlarged gap so that the crab did not need to seek a new and larger shell in subsequent molts. Furthermore, the advantage of this partnership is mutual. On the one hand the crab is provided with a house which adjusts itself to its needs and, with its frieze of tentacles, armed with nettle-like defensive organs, gives him a measure of protection from his enemies. On the other hand, the anemone is carried about by its active partner and is thus afforded a much more varied experience than it would have if growing on a non-motile object. Moreover, the crab, being a greedy feeder, very unlike Chaucer's nun, who, we are told, "let no morsels from her lippes fall," allows many fragments of his meals to float off in the surrounding water, is thus, while eating, doubtless often encompassed by a cloud of crumbs which are as manna to the colony of polyps which thus become literally commensals or true table companions. Such matters are, of course, familiar to students and teachers of zoology, but may not be so familiar to those whose biological training has proceeded along different lines. An interesting feature about this case of commensalism is that, while several hundred specimens were collected in the expeditions of the *Fish Hawk* to the Gulf Stream, these two species were always found associated as commensals. In other words, this particular species of hermit crab was not found except as a commensal of this particular species of sea-

anemone, and this particular sea-anemone was not seen except as a commensal of this particular species of hermit crab. Other cases of commensalism between sea-anemones and crabs were encountered, but none in which the commensals were so faithful to each other as in this.

The material of a haul having been cared for, some of it assorted, labeled and placed in proper preserving fluid, some of it kept in sea-water to be brought alive to the laboratory, we quickly relapsed into that condition of indifference to all things, past, present and to come, which characterizes alike the sea-sick and the aspirants to Nirvana. From this apathetic state we aroused less and less completely as the day wore on. On one or two trying occasions when a heavy swell rocked the *Fish Hawk* in its glassy cradle, much of the material in the last haul, in spite of its great value from the point of view of those who desired an accurate knowledge of the life on the ocean floor, was huddled together and brought back to the laboratory in much the same condition in which it was scraped from the bottom by the trawl.

Before the trawl was put overboard a sounding was made. This was done by means of an ingenious machine invented by Captain Sigsbee of the navy. Instead of the hempen cord of the older machines fine piano wire was employed. A thermometer was also sent down with the sounding lead, the case in which it was enclosed being fastened securely at the lower end, while the upper end was held to the wire by a detachable clamp which was loosed by a lead traveler sent down the wire. This tripped the thermometer, which, in turning over, broke the column of mercury in a bend of the tube, so that the mercury in the filiform portion of the tube remained and could be read in the reversed instrument when it reached the surface. Specimens of the bottom were also obtained. Thus each sounding yielded data of depth, temperature and character of the bottom. Now and then temperatures at different depths in the same locality were taken. The bottom was largely a soft foraminiferal ooze into which the trawl sank, the net sometimes bringing up a large mass of mud, in spite of its having traversed a hundred fathoms or more of clean sea-water on its way to the surface. Occasionally a boulder of fair size was captured, and on more than one occasion the load was too heavy for the net. What came to the surface then was a broken net with, at most, a few small starfishes and serpent-stars clinging to its sides. At such times the comments of Captain Tanner resembled some of the more lurid passages in the novels of Captain Maryatt.

Most of the dredging work of the *Fish Hawk* on the Gulf Stream was done with a beam trawl. The lower end of the net was kept on the bottom by means of leaden weights, while the net itself was buoyed up with hollow balls of thick glass. Sometimes these balls, which were empty when they were started down, came to the surface with water inside. This appears to be due to the extreme pressure which forced water through minute openings in the glass.

In addition to the bottom work some attention was given to the collecting of surface material by means of towing nets and dip nets. Specimens of the Portuguese man-of-war and other Siphonophora were frequently taken as well as *Hippocampus* and various other forms found in the floating gulf-weed. Sharks also were sometimes taken, and, on one trip I remember, three or four porpoises were harpooned. This latter, however, was rather by way of diversion and did not enter into the more serious work of the trips.

About sundown the dredging was discontinued; the ship's course was laid for

Gay Head light, and the thump, thump of the engines began, to keep up all night. On the following morning, soon after sunrise, we would sight Nomansland or Gay Head, and about 9 o'clock were tied up at the wharf in Great Harbor, which, as I remember, was just west of the Luscomb wharf.

Sometimes the fair-weather forecast did not hold good for the whole trip. That meant an uneasy time for Captain Tanner, who, it was said by other officers and by the crew, never slept from the time the *Fish Hawk* put out to sea until she was safe in harbor. Of one of these return trips I have a vivid recollection. With little provocation the *Fish Hawk,* not then provided with a bilge keel, could get up a 45° roll. On this occasion soon after we turned in we had an exhibition of rolling and pitching and various combinations of these severally trying motions that far outdid any former exhibitions of similar nature. Now and then the twin screws, prophetic of the air craft of the present day, were whirling in air, while on board there was a constant rattling and banging, creaking and slamming, with an occasional crash of breaking glass that kept us awake but, so far as I remember, did not cause us any alarm. We did not know much about the sea-going qualifications of the *Fish Hawk,* while we had an extravagant confidence in the ability and caution of the captain.

When we reached port on this trip Captain Tanner put in circulation a new story. In order to understand the point of the story it is necessary first to explain that, just as now the title of a scientific worker in Woods Hole is doctor—so much so indeed that one readily understands why a little girl a few years ago brought word upstairs to her mother that Dr. Boles, the carpenter, was below—so, in the 80's, the title of professor was similarly employed. "The Professor" always, and to all persons, meant Professor Baird. Otherwise the title of professor was bestowed with great liberality and impartiality. Indeed we young assistants were called professors by the crew of the *Fish Hawk* as cheerfully and naturally as the same persons would have given the title to an instructor in the art of self-defense. It so happened on this trip that there were some worthies on board who occupied the spare staterooms, and mattresses were spread in the ward room for the assistants. Captain Tanner said that when it came on to blow he sent his servant, George, below to see if everything had been made secure. When he returned the captain asked: "Well, George, is everything clewed up tight?" "Yas, sah." "You're sure that all's been made snug?" "Yas, sah." "Nothing loose?" "No, sah, 'scusin of a few professors adrift on de ward-room flo'."

On a number of the trips made to the Gulf Stream in 1882 trawl lines and bait were taken along for the purpose of fishing for the tile-fish, whose destruction in enormous numbers had been reported by incoming vessels in the spring of that year. These vessels reported that they had seen countless millions of fish in a dead or dying condition covering thousands of square miles of the sea. The tile-fish (*Lophilatilus chamæleonticeps*) was first taken in 1879. It is a bottom fish with habits much like the cod, and it occurred in vast numbers in the waters bordering the Gulf Stream between Hatteras and Nantucket previous to the season of 1882.[2]

Professor Baird had hoped that profitable fisheries for this species might be opened up, and was very anxious to have specimens secured to prove that the species was still extant. I remember a remark that Captain Chester made as he came alongside

[2] U. S. Fish Com. Report for 1882, pp. 237–94.

the ship on our first trip to the tile-fish grounds, after underrunning the line that had been set for several hours. There were a considerable number of fish of various kinds in the bottom of his boat which he had taken from the line. Some one sung out from the ship asking him if he had taken any tile-fish. His reply was: "Not a lophilatilus, not a chamæleonticeps!" In fact no tile-fish were taken until July, 1899. They were taken again in July, 1900. The hoped-for fisheries for the tile-fish have not yet been realized.

The *Albatross* started on her first trip from Woods Hole July 16, 1883. The trip lasted, as I remembered it, five days. It was my good fortune to be one of the number assigned to this trip. In attempting to review the events of this trip I find that my ability to recall details is limited to a not large number of incidents which rise in my memory like pictures. Life on ship board is somewhat monotonous at best, and when one experienced an undertone of discomfort, there follows the natural tendency to dismiss all recollection of it from the mind.

One experience, however, was so unique, and, fortunately, not associated with feelings of discomfort, that I have often lived it over in my memory. That was when the first haul was made from the deep sea. A depth, as I remember it, of 1,400 fathoms, or nearly 1.6 miles, was shown by the sounding that was made just before the trawl was put overboard. As the dredging operations of the *Fish Hawk* had been limited to localities where the maximum depth was less than half this depth, this was the first experience of any one on board with really deep-sea dredging. Of this event the picture which I carry in my memory is a moving one of perhaps a little more than a quarter of an hour's duration, beginning a few minutes before the trawl appeared and ending after we had spent a few minutes in overhauling the material. The trawl had been over several hours. I have not verified my impressions, but I think it was possibly as much as six hours. When the indicator showed that the trawl was within a few fathoms of the surface every one began to peer down into the transparent water to catch sight of the messenger that had been on such a strange voyage of discovery. It was long past sunset and quite dark, but the scene was brilliantly lighted by electricity. A strong arc-light suspended over the water made sufficient illumination to reveal a school of flying squid pumping themselves about in the water. The light penetrated to sufficient depth to enable one to trace the wire cable far down until it was lost in the darkness below. For some reason, I do not know why, I glanced around. What I saw and remember would, I think, make a worthy theme for a great painting. In the foreground were the naval officers in their trim uniforms; near them the little band of investigators in their nondescript but not unpicturesque attire. Grouped on the forecastle was almost the entire ship's crew, the white trappings of the sailors standing out bravely under the rays of the powerful electric light. Above, below and around about, darkness. The picture was given the needed motif by the approaching trawl upon which all eyes, but my own for a brief interval, were centered. I find myself still as a somewhat detached spectator recalling this scene, and think of this little hemisphere of light in the general gloom that shrouded the great expanse as symbolic of the light of science in the world, which is shining not only to reveal the things that may be seen, but striving to illumine the depths and thus bring to the surface a knowledge of things that lie deeply hidden. This scene lasted but a short time. Pres-

ently we could discern, far down in the transparent waters, a formless thing that quickly took shape, and then the trawl was hauled above the surface, the boom swung in, the net emptied into the great sieve, and we had our first view of living examples of the abyssal fauna. Those forms that lay in the sieve had, only an hour or two before, been resting on the ocean floor where their ancestors had lain undisturbed through the ages of the past with no traditions to affright them by visions of some mysterious being reaching down to snatch the dwellers of the abyss to the unknown regions above.

We had become familiar with the rich and varied fauna of the continental slope, and some of the party had had much experience in dredging in depths of as much as 500 fathoms, but among this material, not large in the mass, were forms that at first no one could assign even to a probable phylum. For example there were a half dozen or more curious-looking objects, not unlike in shape and size to an ordinary five-cent loaf of bread, perhaps a little flatter, and in color and consistency resembling the compound ascidian known as sea-pork. When these objects were brought to the attention of the mollusk specialist he would have nothing to do with them, saying that they were ascidians, or, possibly, worms. The annelid specialist passed them by. It was really not until some of these puzzling creatures had been lying for some time in a tub of sea-water that they were seen to be holothurians, sea-cucumbers of unusual appearance plucked from the abyss. Details of this deep-sea fauna may be obtained from the published reports of the Fish Commission. A strange world was opened up to the imagination by these creatures from the depths: Fish with eyes living in those regions whither the light of day can not penetrate! Whence comes the light which the presence of organs of sight implies? Gorgonia corals, slender and fragile and as delicate as the finest grasses of autumn, shining in shadow with a brilliant phosphorescent light, suggest that if we could see this ocean floor, we would see it dimly illuminated by the phosphorescence of its living denizens, among them groves of gorgonians, motionless in the currentless water and shining with a light literally not seen on sea or land.

I propose now to record brief memory sketches of some of those who were associated with the Fish Commission at the Woods Hole laboratory in 1882 and the years immediately succeeding.

SPENCER FULLERTON BAIRD

Information regarding the life and works of this great American can be had from the published accounts. My purpose here is simply to record a few personal recollections.

I first met Professor Baird in the summer of 1882 when I came to Woods Hole as an assistant of Professor Verrill. About the first thing he said to me was to ask what particular field of zoology I was interested in. By this question I can see now two striking characteristics of Professor Baird's mind: First, his interest in young men who were inclined to the study of nature, and, second, his conviction that such study was best begun by becoming familiar with some particular group of animals. He was then about 60 years of age but looked older than his years. He was a large man, probably fully six feet in height, and possessed of a powerful frame. He stooped slightly, his movements were rather slow and his manner deliberate. His hair and beard were becoming gray. He had a kindly smile, a genial but quiet manner, and a bearing which might not improperly be called patriarchal. He had a wholesome sense of humor,

and was not unacquainted with some of the lighter literature of the day. He read with zest, as many of us did, Rider Haggard's "King Solomon's Mines," and was so much interested in Mrs. Burnett's "Little Lord Fauntleroy," which came out in serial form in *St. Nicholas,* to which he was a subscriber, that he asked the author's husband whether the story had been completed, or whether Mrs. Burnett was supplying copy to the magazine month by month. He was much relieved when told that the manuscript for the entire story had been given to the publishers, since he could now go on with the reading without fearing that some calamity might happen to the author that would prevent her finishing the story. He gave the impression of being one who had succeeded in establishing entire control over himself. I never saw him roused out of his habitual serenity but once. That was when a collecting expedition for a special purpose was being delayed in its starting because the commander of the *Lookout* wanted to finish a game of tennis he was playing on the grounds near the Dexter House. (The *Lookout* was a steam-yacht used by Major Ferguson, the assistant commissioner.) When it was reported to Professor Baird that the expedition was being delayed he left his office and walked at a very rapid pace down toward the laboratory on Little Harbor. The commander of the *Lookout,* sighting Professor Baird bearing down upon him under full steam, abruptly suspended his game and a few minutes later the *Lookout* was under way.

Professor Baird's knowledge of living things, especially of fishes and birds, was extensive, exact and detailed. He belonged to the older school of naturalists whose view of nature was bounded by no narrow horizon. Unfortunately for him and for science his later years were encumbered by administrative details which, although he attended to them apparently without worry, were often perplexing, always time-consuming, and grew in volume with the years. As secretary of the Smithsonian Institution and as commissioner of fish and fisheries his administrative burdens were very great. His nature was such that he could not easily shift burdens to other shoulders. As a consequence of all this he suffered the penalties that follow long hours at his desk substituted for a life that had been formerly in good part spent in the open.

In the interval between the summers of 1886 and 1887 his health failed, and in August, 1887, he died in the residence building into which he and his immediate family and the greater family making up the commission force had moved but three years before.

The funeral services were read by the rector of the Episcopal Church of Woods Hole. To the prescribed church service were added two of the beatitudes which appeared to those who had been associated with him most intimately to reflect the high points of his character. They were the ones which pronounce blessings on the peace-makers, and on those who are pure in heart.

Professors A. E. Verrill and Sydney I. Smith are best known to Woods Hole workers for their voluminous and invaluable report on the "Invertebrate Animals of Vineyard Sound and Adjacent Waters." They were alike in that they were zoologists of unflagging zeal. In all other particulars they were unlike and good-naturedly antipathetic. The one was unemotional, dogged, and, to those who did not know him well, seemingly, at times, crusty. The other was quick, vivacious, open and frank in his manner at all times and to all persons. They invariably took opposite sides of any question that came up for discussion, whether it was scientific, political,

theological or philosophical. The only adverse criticism that I ever heard passed upon their use of time was that they often wasted it in argument over questions which, however they might be settled, if they ever were settled, would not advance human knowledge appreciably, or improve human practise materially. It must be remembered, however, that they were both prodigious workers and that their argumentation was about their only recreation. They did not smoke, and, indeed, were abstemious in all their habits, except in the matter of debate.

Professor Verrill's memory for details was almost uncanny. It was generally believed among us younger men that he could tell correctly at any time the exact number of spines on any parapodium on any species of annelid that he had studied, and he had studied those of the New England coast so effectually that no one has attempted to do much in a systematic way since his time. It was a matter of surprise to those who came to know him well to discover in him a kindly heart and a genial nature. It is a pleasure to record that he is still vigorous and complaining, as usual, because there are not more than twenty-four hours in the day. Professor Sydney Smith, too, is still much alive, and in spite of the great affliction in the loss of his sight, is still unquenchably bright and cheerful.

A peculiarity which Professor Verrill possessed as an arguer may be commended to any who may have to play the part of disputant. No matter what the nature of the interruption might be, or how often the interruptions were made, he never allowed them to divert him from the main course of his argument. I have often heard Mr. Sanderson Smith engaged in a furious debate with Professor Verrill, generally during the progress of dinner, where the fury, however, was all on the one side, and manifesting itself in frequent and energetic interruptions and expostulations, during which Professor Verrill would patiently pause, and, after the breath of his opponent was exhausted, take up his argument where it had been interrupted, and, with even voice, continue as if nothing had been said on the other side. By and by, at the proper place he might reply to the interjected arguments.

Richard Rathbun was working in the laboratory in those days. His special interest then was in parasitic copepods. He was a most industrious worker and smoked an amazing number of cigarettes while at work. His tireless industry in those days was prophetic of his subsequent, indefatigable, vacationless, administrative labors to which the splendid achievements of the National Museum are in no inconsiderable degree due.

George Brown Goode was one of the most well-balanced minds it has been my privilege to know. I remember very well his wonderfully clear and honest eye, his great expanse of forehead, his ready and intelligent interest in what we younger men were working at, his wise and stimulating suggestions. It is much to be regretted that he had not been chosen by one of the great universities, where, in surroundings less permeated with administrative detail, he might have developed the talents which I am sure would have made of him a great teacher, with a longer span of life than was his portion.

John A. Ryder, the most gifted, the most original, the most profound, the most unconventionally human of them all, withal a most likable man, stands out prominently among the workers at the Fish Commission laboratory in the 80's. Often have I sat in wonderment as I listened to his conversa-

tions, which were, indeed, largely monologues, and recall also a remark of Rathbun's, made a few years later. He said that Ryder would awaken lively interest at the meetings of the Biological Society in Washington, and hold their undivided attention throughout the entire meeting, although, often, he confessed, no one was exactly certain what he was actually talking about. He was wonderfully suggestive and always interesting. After having been a member of the faculty of the University of Pennsylvania for but a few years, he died at a comparatively early age. His death, as was that of the talented and beloved Montgomery, who some years later succeeded him to the same chair, was a calamity to the science of biology in this country.

Theodore N. Gill appeared to me to be a rather elderly man in 1882, but he could not have been much above fifty years of age. He was then and, unless his memory has yielded to the weight of years within the past few months, still is an animate ichthyology in himself. How a memory such as his could develop in these days of printed books, with their tabulated lists and bibliographies alphabetically arranged for ready reference, is a marvel. Names of varieties, species, genera, families, orders, synonyms, authorities, morphological details, literature in many tongues, seemed to be always at hand and ready for immediate use. In the variety, extent and accuracy of his knowledge he stands in a class by himself among the men I have known.[3]

Dr. Jerome Kidder, naval surgeon, was another of the interesting and capable men that Professor Baird attracted to himself and the commission. He had charge of such investigations as required a knowledge of chemistry. His personality is still a very real presence in my memory where he stands as a model of good-breeding, good-humor and good-fellowship. He was possessed of intellectual endowments of signal brilliancy. His early death was mourned by a much wider circle than that bound to him by the ties of kindred.

[3] Professor Gill died September 25, 1914, aged seventy-seven.

Tarleton H. Bean was not engaged in field work much of the time in the years of which I am speaking, although he had been much in the field in the earlier days of the commission. As I remember him he was always animated and cheery, abounding in interesting and amusing anecdote, with an extensive and accurate knowledge of fishes and their ways.

Captain Z. L. Tanner, in 1882, was in command of the *Fish Hawk* whose construction he had superintended. Before that time he had been in command of the *Speedwell.* When in 1883 the *Albatross* was placed in commission he became her commander. While a naval officer with the rank of captain, he was not a graduate of the Naval Academy, but had been promoted for distinguished services in the Civil War. He had a florid complexion, a somewhat harsh voice, and a bluff and hearty manner, such as one naturally associates with the typical ship's captain. He was a strict disciplinarian, but just and impartial, and highly respected by all who served under him, or were in any way associated with him.

Captain J. W. Collins was the designer of the U. S. Fish Commission schooner *Grampus* and her first skipper. The *Grampus* was intended to be a model fishing schooner, and is distinguished as the prototype of the *We're Here* of Kipling's "Captains Courageous." He is remembered by me for his cordial and approachable maner, his profound knowledge of the fishing industry, especially on the Banks,

and for his narratives of his own personal experiences and of those of others. One incident, the truth of which I have no reason to doubt, was that of two of his acquaintances, who loaded two dories from the flesh of a giant squid, which they found floating at the surface, leaving an amount which they estimated would have made another dory load. Other incidents of his narrating were not meant to be taken literally, as, when speaking of his experiences in Copenhagen, when attending an international fisheries meeting, where he said that it rained so much that horses frightened at a person who was not carrying an umbrella. Then there was his story of the commander of a vessel, who, sailing into his home port on the Norway coast when there happened to be no fog, did not recognize the place, and accordingly put out to sea, when, the usual fog setting in, he succeeded in a few hours in making his own familiar harbor.

Captain H. C. Chester had charge of the collecting apparatus and superintended the dredging operations. The trawls and nets were stored in what is now called the Stone Building, then known as the Old Candle Factory. Captain Chester was an ingenious and true son of the Nutmeg state. His inventive genius was highly valued by Professor Baird, as an examination of the Reports will show. He abounded in quaint and original humor. He had had much experience as a sea-faring man. It was well known among us that Captain Chester had taken a prominent part in the *Polaris* expedition, and that it had been due to his unflagging good-spirits in the presence of intense cold and extreme privation that the party that returned by land was brought through safely. We often tried to get him to tell us about that expedition but never succeeded. He preferred to talk about Noank, Connecticut, which he invariably spoke of as "the garden spot of the earth," and a famous variety of apple, which his father developed to grow in an orchard on a steep hill side. These apples, he averred, were flat on one side, which kept them from rolling down hill into his neighbor's field below.

Sanderson Smith I remember as an elderly man, probably Professor Baird's senior. I think that he had been an engineer by profession, but with a strong bent towards natural history. His work for the commission, besides looking after the mollusca, consisted in tabulating results of soundings, dredgings, temperature data, and the like. He was a model of good nature, more ready to do favors for others than to minister to his own comfort. In those days there were many visitors to the laboratory and Sanderson was always ready to drop his work, which the rest of us sometimes did reluctantly, to show visitors over the laboratory. James H. Emerton, Professor Verrill's artist, was very patient under these visitations to his table, but one day, I remember, he complained vigorously because some of the visitors had breathed down the back of his neck as they were watching him make a sketch.

Soon after we moved into the new residence building some of us one morning found Sanderson looking with a much puzzled expression at the new clock, across the face of which was printed a direction for winding, but which he was interpreting as a weather forecast. Pointing to it with an air of indignant agitation he said: "Why, why, why, what, what, what does that mean? 'Wind every Monday morning'!"

Leslie A. Lee was a most cheery and well-beloved member of Professor Baird's larger family in the 80's. He was an enthusiastic collector, capable of the best work, but whose love of collecting and of first-hand

observation overrode his inclination to put his knowledge into printed form. His publications bear no proper relation to his work and knowledge.

H. L. Bruner, one of the assistants in my time, grave and serious as a young man, was assiduous and painstaking in his work, and immune to sea-sickness. J. Henry Blake, who succeeded Emerton as artist, and was in the laboratory for three or four years, is another who has built himself a pleasant habitation in my memory.

Among the young men who worked in the laboratory on Little Harbor in 1882 and 1883 were also B. F. Koons, W. E. Safford, Peter Parker and Ralph S. Tarr. Tarr was so much impressed with the accuracy of Vinal N. Edwards as a weather forecaster that he declared that if Vinal Edwards said it was not going to rain in the afternoon he would still believe him even if his own senses told him that there was a genuine downpour.

A year or two later, Professor W. Libbey for at least a summer, and Professor W. B. Scott, as an occasional visitor, brought new ideas and methods, and Dr. McCloskie, too, brought a breeze of enthusiasm with him that was most refreshing.

Among the numerous visitors to the laboratory who tarried long enough to impress their strong personality on us younger men I recall most vividly and pleasantly Professor Cope and Doctors Osler and S. Weir Mitchell.

It is not my purpose to extend these reminiscences much beyond the days when Professor Baird's presence was the most potent influence in this community. I shall, however, insert a few observations on the season of 1889.

Returning after a year's interval, I found a complete change in the personnel, and but little change in the spirit which pervaded the laboratory. The laboratory was under the efficient directorship of Dr. H. V. Wilson. The laboratory workers still had their mess in the residence building, where I greatly missed the benign presence of Professor Baird.

There was here, however, that summer, a man of quiet and unobtrusive manner, who, as it seems to me, had elements of real greatness in his nature in higher degree than any one whom it has been my fortune to know. That was Professor W. K. Brooks.

It was an interesting lot of young men that I found in the laboratory of the U. S. Fish Commission in 1889. There was E. A. Andrews, then and still of Johns Hopkins University; H. V. Wilson; F. H. Herrick; E. R. Boyer, C. B. Davenport, and W. M. Woodworth, post-graduate students of Harvard; M. C. Greenman, a post-graduate student of the University of Pennsylvania; R. P. Bigelow, C. F. Hodge, T. H. Morgan, and Sho Watase, post-graduates of Johns Hopkins. Of this group, Hodge, who has recently molted the effete east, has written of dynamic biology. I think it can be said with truth that he and the others of this little group, after the quarter of a century that intervenes, are to be reckoned as among the potent dynamic agencies in the biological science of this generation.

The Marine Biological Laboratory had been opened the previous summer. Dr. Whitman had already inaugurated the custom of having evening lectures. They were held in the one laboratory building in the room, I think, in which the invertebrate course is now conducted.

In 1889 cross-breezes were ruffling the calm of the biological atmosphere. There were some in the laboratory who stoutly denied that the surroundings did or could have any manner of influence on the germ cells. There was no god in animated nature but heredity and Weismann was his prophet. In those days also the neo-La-

marckians were in the land; sturdy Americans they were, who hardened their hearts at ideas made in Germany. One evening, I remember, we went over to the Marine Biological Laboratory to hear a lecture by Professor E. D. Cope. The lecture was on some mechanical factors in evolution. Professor Cope, the most scintillatingly brilliant American man of science that has yet appeared, told us about the shapes of the carpal bones in a number of extinct artiodactyles which he had been studying. He illustrated his lecture with numerous crayon sketches which he made while he was talking. His conclusion was that these bones owed their shape to the mechanical effects of pressure and stress, and were thus evidence of the inheritance of characters that had become impressed on lines of descent by the surroundings, and hence might be said to prove the inheritance of acquired characters. I recall that one of the young men, upon our return to the Fish Commission laboratory, characterized Professor Cope's lecture as puerile, which I did not think then, nor do I think now, is exactly a word that is needed to describe anything which Professor Cope said or did in 1889.

It has been my fortune once and again to hear more or less patronizing criticism of the way time was spent in the work of collecting and classifying the animal and vegetable forms which inhabit the waters of the Woods Hole region. Doubtless the time could have been better spent, but this remark may be made with equal justice concerning any sort of human endeavor. It may not be amiss to say that whatever the character of the publications of these earlier workers, the conversations to which, as a young man, I listened between such men as Professors Baird, Gill, Verrill, Smith, Goode, Ryder and Cope, contained nothing about priority of names, and little upon taxonomy in general, while they did abound in discussions of such matters as the habits and distribution of animals, adaptation, development, function, behavior and heredity.

Looking back on the laboratory activities of those days and comparing them with the present with its varied application of the sciences of chemistry and physics to the study of the phenomena of life, the work done here in the 80's may seem narrow. It should be remembered, however, that no science has sprung at once into maturity. The immediate problem before the Commission of Fish and Fisheries was that of acquiring all the knowledge obtainable of the fishes of our coast and of their food and environment. It is not conceivable that this knowledge could have been gained in any other way than by a study of the conditions at first hand. Doubtless our knowledge is to be vastly extended by those experimental methods whereby animals are subjected to conditions which do not exist in nature, but such investigations, however valuable they may be in refining and extending our knowledge of life, would have been as much out of place in the days of Baird and Agassiz as the automobile and the locomotive would have been in the forests of this country 200 years ago.

Those of us who breathed the serene atmosphere of the days of Professor Baird, and have continued work somewhat similar to that which we began some three decades ago, have inherited, I trust, some of his kindly spirit that should enable one to listen to criticism with equanimity and to endure patronage without agitation of mind. Thus one may dwell beside the road and be a friend to the passing biological pageant. So he could be a respectful onlooker when, in 1898, he beheld the passing show, brave with many colors; when newborn ideas in biology must first be baptized in corrosive sublimate and then decked in

the royal purple of hematoxylin before they could be exposed to the awed gaze of the beholder. Likewise, in 1899, when the name of vom Rath was a word to conjure by; continuing in 1900, when nerve endings were the end and aim of all that was worth while, he could only wonder and be silent. I remember in 1899 asking an acquaintance that I had made the previous year what he was working at. His reply was: "I have been working for the past two years on the nerve endings of *Arenicola,* but have not got any results yet." But with the introduction of experimental methods the epoch of zoological fads came to an end. Now our dweller beside the road listens with appreciation to illuminating lectures on a variety of subjects, where problems new and old are attacked from various and unusual points of approach and by a multiplicity of methods. He listens with delight to the lecturers who announce the results of their researches, but with a conviction that is sometimes in inverse proportion to his knowledge of the subject under discussion. Often he is inclined to accept these conclusions with enthusiasm, only to have his enthusiasm chilled when he hears what the lecturer's friends have to say about the lecture on the following morning.

When, in more recent years of the Fish Commission, or Bureau of Fisheries, as it is now called, Parker, with no other equipment than a pair of hat-pins, demonstrated the functions of the otoliths of fishes, and, with an apparatus which he constructed with the aid of a saw and hammer, supplemented by a simple surgical operation, discovered the function of the lateral line in fishes, and in equally simple fashion cleared away the fog that enveloped our knowledge of how much or how little fishes hear sounds either above or beneath the water; when Sumner showed by ingenious but easily worked experiments the degree to which flat-fishes adapt themselves to their surroundings; when Field gave proof as convincing as that of the proverbial pudding that *Mytilus edulis* is truly an edible, and that the smooth dog-fish by some other name would be eagerly sought in the markets; when these pieces of original work and others like them, of which many could be named, are considered, we feel that they represent in good degree the kind of investigation which would have won Professor Baird's hearty sympathy and approval. I am inclined to think, however, that he would have viewed with still greater favor the Bulletin of the Bureau of Fisheries for 1911 reporting a Biological Survey of the Waters of Woods Hole and Vicinity.

Edwin Linton

Washington and Jefferson College,
Washington, Pa.

THE INTERNATIONAL ENGINEERING CONGRESS

There will be held at San Francisco, from September 20 to 25, 1915, an International Engineering Congress, organized and conducted under the auspices of the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers and the Society of Naval Architects and Marine Engineers. General G. W. Goethals has consented to act as honorary president and is expected to preside over its general sessions. The following eminent engineers have consented to serve the congress as honorary vice-presidents: Professor Richard Beck, Sir J. H. Biles, Otto T. Blathy, Commander Christian Blom, Professor André Blondel, Dr. C. E. L. Brown, Dr. Emil A. Budde, Henry Le Chatelier, Professor Hermann Hullmann, Wm. Henry Hunter, Professor Luigi Luiggi, Rear Admiral Yoshihiko Mizutani, W. M. Morday, Sir Charles Parsons, Jean L. de Pulligny, V. E. Timonoff, R. P. J. Tutein-Melthenius, H. H. Vaughn, Sir Wm. Willcocks.

The papers to be presented before the congress will cover the general field of engineering and will be published in ten volumes.

The papers in general are intended to treat the various topics in a broad and comprehensive manner and with special reference to the important lines of progress during the past decade, the present most approved practises and the lines of present and future development.

The general fee for membership in the congress is $5, which will entitle the member to receive the index volume and any single volume of the transactions he may select, together with the right of participation in all the general activities and privileges of the congress. The committee of management must know at the earliest practicable date the number of members in the congress. Effective plans in regard to the publication of the transactions, as well as all arrangements looking toward the proper ordering of local affairs during the week of the congress, require this information.

It is expected that there will be arranged a number of excursions to points of engineering and general interest within practicable reach of San Francisco, and every effort will be made to enable visiting engineers to inspect personally such engineering works as are especially typical of engineering on the Pacific Coast. Further information of general interest and importance regarding the congress will be given publicity through the technical press, and to all subscribers notice will be sent containing more complete information as to papers, sessions of the congress, excursions, travel routes and itineraries, hotel rates and accommodations, and other matters of importance.

Mr. W. F. Durand is chairman and Mr. W. A. Cattell is secretary of the committee of management, the address of which is Foxcroft Building, San Francisco.

EDITH JANE CLAYPOLE

The following minute in memory of Dr. Edith J. Claypole, who died in March, as a result of infection incurred in the preparation of typhoid vaccine for the armies of Europe, has been adopted by the Science Club of Wellesley College. It has also been embodied in the minutes of the Academic Council:

The Science Club of Wellesley College records its sense of loss in the death of Edith Jane Claypole, a charter member of the club, its first secretary, and active both in its foundation and in its early conduct. Descended from a father who was himself a distinguished man of science, and receiving her early education at home, she was by inheritance and training exceptionally fitted for the line of work to which she chose to devote her life. She early exhibited unusual capacity for research; in the field of cell-studies and pathology her many papers are evidence of her power of achievement. As a teacher she opened the eyes of her students to the beauty and significance of living things, revealed to them the method of science, and inspired them with the high nobility of its aims. Members of other departments recognized the open-mindedness and appreciation that marked her attitude toward all branches of scientific activity. As a physician she early became interested in preventive medicine, and to its advance she devoted herself without reserve. Through her researches in pathology, particularly in certain obscure cases of infection and in typhoid immunization, she won distinction, and in the application of these researches to the needs of humanity, she has now crowned her service with the gift of her life. Her charm of manner and winsomeness of spirit, with a strong and wholesome nature, quick and tender in its response to the needs of others, and her unfailing steadfastness in friendship, endeared her to large circles. We, the members of the Science Club, express our sadness in the loss of a comrade, and our appreciation of her service to science and to humanity.

SCIENTIFIC NOTES AND NEWS

The Civic Forum Medal of Honor awarded annually for "distinguished public service" has been presented to Mr. Thomas A. Edison.

Dr. Abraham Jacobi was the guest of honor at a dinner in the Hotel Astor given by the physicians and officers of the Bronx Hospital on the occasion of his eighty-fifth birthday.

At the annual meeting of the American Academy of Arts and Sciences, held on May 12, at its house, 28 Newbury Street, the following officers were elected:

President, Henry P. Walcott; *Vice-presidents*, Elihu Thomson, William M. Davis, A. Lawrence

Lowell; *Corresponding Secretary*, Harry W. Tyler; *Recording Secretary*, William Watson; *Treasurer*, Henry H. Edes; *Librarian*, Arthur G. Webster; *Chairman of Rumford Committee*, Charles R. Cross; *Chairman of C. M. Warren Committee*, Henry P. Talbot; *Chairman of Publication Committee*, Edward V. Huntington; *Chairman of House Committee*, Hammond V. Hayes.

At the annual election of officers of the Boston Society of Natural History, the following were chosen: *President*, Edward S. Morse; *Vice-presidents*, Robert T. Jackson, Nathaniel T. Kidder, William A. Jeffries; *Secretary*, Glover M. Allen; *Treasurer*, Edward T. Bouvé; *Councillors for Three Years*, Charles F. Batchelder, Reginald A. Daly, Merritt L. Fernald, William L. W. Field, John C. Phillips, William M. Wheeler, Edward Wigglesworth, Mary A. Willcox.

The Barnard gold medal awarded every fifth year by Columbia University, on the recommendation of the National Academy of Sciences, "to that person who, within the five years next preceding, has made such discovery in physical or astronomical science, or such novel application of science to purposes beneficial to the human race, as may be deemed by the National Academy of Sciences most worthy of the honor," will be given this year to William H. Bragg, D.Sc., F.R.S., Cavendish professor of physics in the University of Leeds, and to his son, W. L. Bragg, of the University of Cambridge, for their researches in molecular physics and in the particular field of radioactivity. The previous awards of the Barnard medal have been made as follows:

1895—Lord Rayleigh and Professor William Ramsay.
1900—Professor Wilhelm Conrad von Röntgen.
1905—Professor Henri Becquerel.
1910—Professor Ernest Rutherford.

The Butler gold medal to be awarded every fifth year by Columbia University for the most distinguished contribution made during the preceding five-year period to philosophy or to educational theory, practise or administration will be given to the Hon. Bertrand Russell, F.R.S., lecturer and fellow of Trinity College, Cambridge, for his contributions to logical theory. The Butler silver medal is to be awarded to Professor Ellwood Patterson Cubberley, of Leland Stanford Jr. University (A.M., Columbia, 1902; Ph.D., 1906), for his contributions to educational administration.

The city of Philadelphia, acting on the recommendation of The Franklin Institute, has awarded the John Scott Legacy Medal and Premium to Herbert Alfred Humphrey, of London, England, and to Cav. Ing. Alberto Cerasoli, of Rome, Italy, for the Humphrey Pump, a device for raising water by the direct application of the explosive energy of a mixture of combustible gas and air. In the pump, the momentum of a moving column of water is utilized to draw in and compress in a suitable chamber a charge of the gas mixture whose explosion raises the water.

The Edward Longstreth Medal of Merit of the Franklin Institute has been awarded to the late Mr. George A. Wheeler for his escalator. The basic invention was first disclosed in a patent granted to Mr. Wheeler in 1892, and a number of patents were subsequently issued to him for improvements and developments.

At the annual meeting of the Boston Society of Natural History, held on May 5, the two annual Walker Prizes in Natural History were awarded. The first, of sixty dollars, was given to Miss Emmeline Moore, of the department of biology, Vassar College, and the second, of forty dollars, to Miss Edith B. Shreve, of Tucson, Arizona. The two successful essays were entitled, respectively: "The Potamogetons in Relation to Pond Culture" and "An Investigation of the Causes of Autonomic Movements in a Succulent Plant." These annual prizes are awarded for the two best essays submitted on subjects selected by a committee of the society. For the years 1916 and 1917 the committee announces that competitive essays will be received on "any subject in the field of natural history" thus allowing wide scope.

The Howard Taylor Ricketts Prize for research in the department of pathology and hygiene and bacteriology at the University of

Chicago has this year been awarded to Miss Maud Slye for her work on "The Influence of Inheritance on Spontaneous Cancer Formation in Mice." This prize is awarded annually on May 3, the anniversary of Dr. Rickett's death from typhus fever acquired while investigating that disease in Mexico City.

Mr. C. E. Lesher, associate geologist of the land-classification board of the United States Geological Survey, has been assigned by the director of the survey to take charge of the work of compiling the statistics of coal production published in the annual volume "Mineral Resources." This work has heretofore been directly under Edward W. Parker, whose resignation from the Geological Survey is effective July 1.

Dr. Edward C. Rosenow, of the Memorial Institute of Infectious Diseases, Chicago, has been appointed chief of bacteriologic research, Mayo Foundation, Rochester, Minn. Dr. Rosenow will begin his new work on July 1.

The following have been appointed by the trustees of Columbia University as the board of managers of the George Crocker Special Fund for Cancer Research for three years from July 1 next: Dr. T. Matlack Cheesman, Dr. Walter Mendelson, President N. M. Butler, Dean Samuel W. Lambert, Professor Warfield T. Longcope, Professor William G. MacCallum and Professor Francis Carter Wood.

Dr. J. Alexander Murray has been appointed general superintendent of the Imperial Cancer Research Fund and director of the laboratories, in succession to Dr. E. F. Bashford.

Dr. Lentz, director of the Prussian imperial health office, has been appointed the reporting councilor in the medical department of the ministry of the interior, as successor of Dr. Abel, who has been transferred to the Institute of Hygiene at Jena.

Mr. Leo E. Miller writes to the American Museum of Natural History from South America that he has completed his work in Antioquia and on March 30 sailed from Barranquilla to Colon *en route* to Bolivia, where it is proposed to inaugurate a zoological survey similar to that which the museum has conducted in Colombia for the past five years. Mr. Miller's collections, amounting to two thousand birds and mammals, has been received by the museum.

Dr. Robert F. Griggs, of the department of botany at the Ohio State University, has been selected by the National Geographic Society to lead an expedition to study the vegetation of the Katmai district in Alaska. The purpose of the expedition is to study the means by which vegetation gains a foothold on the volcanic ash with which the country was covered by the eruption of Katmai in 1912. This ash-covered region is many hundreds of miles in extent, covering a portion of the Alaska Peninsula and the greater part of Kadiak Island.

An excursion to the Hawaiian Islands, under the charge of Professor George H. Barton, director of the Teachers' School of Science, will leave Boston on July 4.

Mr. Lloyd B. Smith, of the Associated Geological Engineers, has returned to Pittsburgh, after spending three months in the oil fields of Mexico and Central America.

Alvin J. Cox, Ph.D. (Breslau), instructor in chemistry at Stanford University from 1904 to 1906, has returned to San Francisco on a leave of absence to take charge of certain features of the Philippine exhibits at the exposition. He has held the position of director of the United States bureau of science in the Philippine Islands.

Professor W. H. Kavanaugh, head of the experimental engineering department, University of Minnesota, has been appointed a member of the international jury of award, department of machinery, at the Panama Exposition, San Francisco. Professor Kavanaugh is spending the month of May at the exposition judging exhibits.

Professor H. H. Stoek, head of the department of mining engineering of the University of Illinois, has been granted a leave of absence to act as a member of the Committee on Awards for Mining Exhibits at the San Francisco Exhibition. Professor Stoek is now in California.

PROFESSOR ROBERT A. MILLIKAN, of the University of Chicago, delivered the "Thomas Lectures" at Richmond College in April. The general topic was "The New Physics." In his first lecture Dr. Millikan recounted some of the important recent discoveries in the field of radioactivity and X-rays and discussed the significance of these facts to modern science and life. The second lecture was given to a description of some of the properties of the electron, and the methods by which these properties had been discovered.

DIRECTOR JOHN F. HAYFORD, of the College of Engineering of Northwestern University, addressed the engineering sub-division of the Chicago Association of Commerce on Friday evening, May 14, on the subject "Chicago as an Engineering Center."

PROFESSOR LOUIS KAHLENBERG, of the University of Wisconsin, delivered the annual address before Phi Lambda Upsilon, the honorary chemical society of the University of Michigan, at Ann Arbor, on May 13. The subject was "A Neglected Principle of Chemistry and some of its Applications."

UNIVERSITY AND EDUCATIONAL NEWS

THE trust estate of $3,250,000 left by Miss Elizabeth Thompson, will on the death of her brother and sister be equally divided among the following institutions: The Children's Aid Society, the New York Association for the Improvement of the Condition of the Poor, the New York Historical Society, the Society of the New York Hospital, the Presbyterian Hospital and Columbia University.

THE Michigan legislature has appropriated $350,000 for the erection of a new university library building for the University of Michigan.

THE James Buchanan Brady Urological Institute of the Johns Hopkins Hospital, made possible through Mr. Brady's gift of $600,000, was formally opened on May 4. Among those who made speeches were Dr. Hugh H. Young, head of the institute, and Dr. William H. Welch.

DR. THOMAS ORDWAY, of the Harvard Medical School, has accepted the deanship of the Albany Medical College. Dr. Ordway was formerly professor of pathology in the medical school of which he now becomes dean.

G. V. COPSON, now specializing in dairy bacteriology in the University of Berne, Switzerland, has been appointed instructor in pathological and dairy bacteriology at the Oregon Agricultural College.

DR. E. F. MALONE, of the department of anatomy, University of Cincinnati, has been promoted to be associate professor of anatomy.

DR. ERNEST LINWOOD WALKER, formerly chief of the biological laboratory of the Federal Bureau of Science, and chief of the department of medical zoology at the University of the Philippines, Manila, has been appointed associate professor of tropical medicine at the George Williams Hooper Foundation for Medical Research, University of California.

PROFESSOR R. C. LODGE, who has been this year at the University of Minnesota, has been appointed professor of philosophy and psychology at the University of Alberta.

DISCUSSION AND CORRESPONDENCE

BALANCED SOLUTIONS AND NUTRITIVE SOLUTIONS

MR. TRUE's article on "Antagonism and Balanced Solutions"[1] closes with the following remarks.

> In both sea water and the more or less dilute nutrient solutions present in the soil, normal life is sustained, as a rule, only in mixtures of proper proportions and necessary concentration. Since salts are required in both cases to overcome the harmful action of pure water, as well as that of the salts themselves, there seems to be no reason to seek to limit the use of the term "balanced solutions" in the manner suggested by Loeb and Osterhout. Unless we admit that malnutrition due to a deficiency in nutrient salts is a form of toxicity excited by the substances present, we can hardly escape the alternative proposition that the missing salts are injurious *in absentia*.

Since the writer is responsible for the introduction of the term physiologically balanced salt solutions,[2] he may be pardoned for pointing out that in his opinion neither of the

[1] SCIENCE, N. S., XLI., No. 1061, p. 653, 1915.

[2] Loeb, *Am. Jour. Physiol.*, III., p. 445, 1900.

two alternatives in the last sentence of Dr. True is correct. The writer defined physiologically balanced salt solutions as solutions in which the toxic effects are annihilated, which each or certain constituents would have if they were alone in solution. Thus the fertilized egg of *Fundulus* develops naturally in sea water, is killed in a pure NaCl solution of the concentration in which this salt occurs in sea water, and is kept alive if some $CaCl_2$ or $KCl + CaCl_2$ is added. Since the egg lives and develops perfectly normally in distilled water the $CaCl_2$ or $KCl + CaCl_2$ are only needed to counteract the directly injurious effects which the NaCl solution produces as soon as its concentration exceeds a certain limit (about $m/8$) (but not to counteract the injurious effects of distilled water which do not exist in this case). The nature of this injurious action of the NaCl solution of a sufficiently high concentration is perfectly well known, since it consists in the injury or destruction of the specific impermeability or semipermeability of the membrane.[3]

The term *physiologically balanced* or *protective* salt solution was intended to be used in contradistinction to the term *nutritive* solution. If from a *nutritive* solution one or the other constituent is omitted (*e. g.*, K or NO_3 in the case of plants or K or the ion NH_4 in the case of bacteria) so that a malnutrition or a deficiency disease follows, it can not be stated that the organism suffers from the toxic effects of the salts left in the solution (as in the case of a pure NaCl solution of a sufficiently high concentration) but it suffers because the missing elements are indispensable building stones in the construction of the complicated compounds of the organism. The writer is not aware that anybody has proved that NO_3 or K or PO_4 in the nutritive solution of a plant are merely needed to overcome the toxic effects of the rest of the constituents of the nutritive solution; while in the case of *Fundulus* the experiments with distilled water show directly that the egg does not depend for the building up of an embryo upon any of the salts contained in the sea water or any other physiologically balanced solution.

In the writer's opinion the last sentence in Dr. True's note should read as follows: A deficiency of nutritive salts deprives the organism of some of the necessary building stones for the construction of its specific complicated compounds, and this deprivation may result in the formation of inadequate or directly injurious compounds, causing the phenomena of malnutrition or of the "deficiency diseases."

JACQUES LOEB

THE ROCKEFELLER INSTITUTE
FOR MEDICAL RESEARCH,
NEW YORK

[3] *Pflüger's Archiv*, CVII., p. 252, 1905; *Biochem. Ztschr.*, XLVII., p. 127, 1912; *Jour. Biol. Chem.*, XIX., p. 431, 1914.

THE TYPICAL CASE EXEMPLIFIED[1]

I RECEIVED three offers when I came up for my degree; two from institutions in the east and one from a typical state university in the northwest. The opportunities for scholarly work were pictured to be as great by the western university as by the two eastern, and the former offered me considerably more in salary than either of the latter. Everything else being equal, the difference in salary decided the case. I came west, was disillusioned, and now wish that I had chosen differently; but, by the light that I had to follow, I could not have made a different choice. Therefore, it is with the purpose of casting some new light upon the offers that come from the west that I now write.

In general, the positions out here seem more attractive than those in the east, because usually the beginning salaries are higher—the fact that the maximum salary is much lower is overlooked or disregarded; and because usually the opportunities for scholarly and research work are represented to be as large. Or, rather, I should say, misrepresented, for all the time that I have had for original work I have taken from my sleep and recreation.

In the correspondence that I had with the head of my department and with the president of the university in reference to the position,

[1] See the letter by Professor Edward C. Pickering, SCIENCE, February 19, 1915, p. 288.

they spoke glowingly "of the opportunities in a comparatively new institution in a rapidly growing section of the country," and assured me that "every facility will be given you to continue your research work." My program as outlined by mail was reasonably light; but when I came to assume my duties I found that I was expected to grade all the quiz and examination papers. Consequently a great part of my time during the first year was spent with the blue pencil. In my correspondence pertaining to the position this sentence appears: "Graduate or advanced student assistance will doubtless be furnished," if I should become unduly burdened with academic work. I have made several requests for assistance, but so far have been denied it.

Nevertheless I was determined to keep the pot boiling, and I was, after a short delay, at work upon a minor problem. My first requisition for apparatus was granted immediately. I was forced to wait three months for my second; and when I made my third request I was asked the startling question, "Are you conducting personal research?" If so, I should have to meet personally the expenses of such work. I could not answer the question at first, for I did not know what personal research was, never having heard the phrase before; but when I learned that work which is self-initiated is personal, I realized that my work belonged to that category. The officer of administration with whom I had this conversation tried to show me that it was an imposition on my part to make this request. Why! had he not done research in San Francisco, in Omaha, in Chicago, in New York, yes, and in London and Paris too—the results of which, he informed me, were published in pamphlet form—and he did not request or expect the university to pay his expenses. So my third requisition was refused. This attitude toward original work is characteristic, and is not due entirely to ignorance of scholarly work, but in part to the importance and emphasis that the university gives to its correspondence and extension work.

These departments receive very liberal support. Courses are given in nearly every subject, and nearly every member of the faculty gives some of his time to extension work; some men give their entire time to it. The extension department is probably the most important in the university. This is due to the fact that the popular lectures which are given by the faculty upon their extension tours offer the best means of gaining the people's good will. Here, where the university and the agricultural college exist as separate institutions, there is much need of this. Public favor means appropriations. Therefore it is not research but extension work that the administration desires.

One's endeavors upon the extension platform soon receive recognition and promotion, whereas research work is disregarded. It is not wanted; it is not encouraged, no matter what may be said to the contrary. I have talked the matter over with several members of our faculty, with men who have been here for eight and ten years, and they agree with me—in fact I have advised with them in writing this letter—that there is no future here for a man with scholarly ambitions. And the pity of it all is that there are many men who have no desire to continue research after their doctorate, and who would be supremely happy in these positions, where the work is new, where the people are eager for knowledge, and where no one is critical; but the administration, by feigning to hold certain ideals, attracts and elects men to the faculty who are entirely out of sympathy with the conditions of their work as soon as they discover them. The man who comes imbued with the spirit of research and who desires to continue his scientific investigation will struggle hopelessly for a year or two against the odds, and will then resign; either resign his position and return east, or resign his scholarly ambitions. If he return east he must start again at the bottom; if he remain at his post he will be discontented in the sacrifice of his ideals—a victim of dry rot.

I feel rather strongly in this matter because I am myself at the parting of the ways. I too must "resign." Which course I shall pursue is a question that is giving me no little concern. It is one, also, that I feel should never

have been forced upon me; but it is one that all who have come out here, with ideals such as mine, have been forced sooner or later to meet. The issue should have been placed squarely before me two years ago when I was considering the position. Had I then known that research was practically impossible I should never have come to the northwest. One can never learn the true conditions of an appointment from correspondence with the administrative officers. They are naturally biased. For that reason I have written this letter. I sincerely hope that it will enable others to choose less blindly than I.

X.

A TYPICAL CASE

Professor ——— graduated at ——— University and, taking a postgraduate course, received the degree of Ph.D. He then went abroad, studied at ——— University, and returned to America, full of enthusiasm for original research. He had published an important memoir for a thesis which was well received, his instructors encouraged him and his fellow students appreciated and were interested in his work.

He now received an offer of a professorship in a small country college, married and began his new life, expecting to continue his investigations. He soon found that almost all his strength was consumed in teaching, and was horrified at the end of his first year that his salary had not been increased, as had been promised upon satisfactory service. This induced him to review his forces and readjust to the situation. He assumed a more sympathetic attitude toward the tyro and looked deeper into the organization and purposes of the institution. He began to fall in with the teaching problem and reduced the expenses of his department by taking a larger number of classes himself and for a nominal sum employed a few bright upper classmen a few hours weekly to do the drudgery. He attacked the problem of efficiency in instruction and found himself well equipped for the undertaking, for the machinery of his superior training gave a diamond point to his drill in the form of system and habits of thought, and this was backed up by the battering-ram of a growing enthusiasm.

He also became interested in the historical and vocational aspects of his subject and began to relate himself and his work to the world he lived in. In process of time his ideas began to show themselves in increased comfort and efficiency in the lives of human beings. His teaching task was now a magnet to all his powers, while his classes forgot their examinations in the joy of their daily lessons.

On the Olympic heights of the university he had learned to despise the rôle of the sturdy farmer and faithful wife who were responsible for his birth and education and much of the ethics of that parental pair had become a mere convention or a timely expedient. But there stole into the years of the busy Ph.D. a renewed conviction of the high worth of social purity, and his fictitious ideas of temperance, kindness, etc., gave way to principles more in keeping with his earlier teaching, while he ceased to despise the ultimate source of his bread and butter.

The finding of such men as this—men adaptable to the highest needs of the small country college—would be a worthy object for a Committee of One Hundred.

S. L. Macdonald

Fort Collins, Colo.

SCIENTIFIC BOOKS

Animal Experimentation and Medical Progress. By William Williams Keen, M.D., LL.D., professor emeritus of surgery, Jefferson Medical College, Philadelphia, with an Introduction by Charles W. Eliot, LL.D., president emeritus of Harvard University. Boston and New York, Houghton Mifflin Company, The Riverside Press, Cambridge, 1914. Pp. xxvi + 312.

In this book Dr. Keen has brought together the thirteen papers on experimentation which he has published in various periodicals during the past twenty-nine years. Nine of these deal chiefly with the contributions which this method of research has made to medical—and chiefly surgical—progress, while the remaining papers are devoted to the antivivisectionists and what they have been doing. Not him-

self an experimenter, but convinced beyond recall of the absolute necessity of animal experimentation, the author is a veteran in its propaganda, and no one writes with fuller knowledge of the facts on both sides, with keener conviction of the correctness of his position, and with a more trenchant pen. With him it is "a common-sense, a scientific, a moral and a Christian duty to promote experimental research," just as "to hinder it, and still more, to stop it would be a crime against the human race itself, and also against animals."

The eminence of Dr. Keen as a surgeon adds all the more value to his opinion of the benefits which human surgery has derived from experimentation. A striking chapter in the book is that on modern antiseptic surgery and the rôle of experimentation in its discovery and development. It gives a graphic picture, first of the pre-antiseptic surgery with its terrors of suppuration, secondary hemorrhage, erysipelas, lock-jaw, blood poisoning, gangrene and high death-rate—a picture all the more graphic because of the author's experience with its realities; then of Lister's work, with his experiments upon one horse and one calf; and finally of the results, with the virtual elimination of the disastrous sequelæ of operations, the extraordinary reduction in mortality, and the wide extension of surgical treatment to formerly forbidden fields. Shortly after the battle of Gettysburg the author was called in one night to five cases of secondary hemorrhage; since 1876, when he began the practise of the antiseptic method, he has not seen as many such cases in all the years that have elapsed, nor has he seen a single case of hospital gangrene. Formerly healing by "first intention" was so rare that its occurrence was regarded as a triumph; now its absence is a disaster. Formerly a famous surgeon lost two out of every three of his patients after the operation of ovariotomy; now the mortality is often less than one per cent. The skull cavity and the abdomen with its organs were once avoided by the surgeon; now they are fearlessly entered. "The only question," says the author, "is, should Lister have made this final test first on a horse and a calf, or on two human beings? Can any one with a sane, well-balanced mind hesitate as to the answer?" "In the past thirty years," he continues, "experimental research has produced a more fruitful harvest of good to animals and to mankind than the clinical observations during thirty preceding centuries."

To the present reviewer that aspect of the antivivisection agitation that is by far the most interesting is the psychology of it. It is characterized preeminently by an exaggerated love for animals, woeful ignorance, a proneness to make strong pronouncements without adequate knowledge, a disregard of facts, a lack of logical reasoning, a tendency to pervert the truth and to ascribe unworthy motives to scientific men, and a general lack of moral balance in propaganda. These qualities have been demonstrated so frequently that they have come to be expected as a matter of course in those who oppose the practise of animal experimentation. As a fact it is rare that one fails to find some of these qualities in all such persons. Dr. Keen has been impressed by this and he states the attitude of many of us when he says: "I have been compelled to conclude that it is not safe to accept any statement which appears in antivivisection literature as true, or any quotation or translation as correct, until I have compared them with the originals and verified their accuracy for myself."

The four chapters here devoted to the antivivisectionists are entitled "Misstatements of Antivivisectionists," "Misstatements of Antivivisectionists Again," "The Influence of Antivivisection on Character" and "The Antivivisection Exhibition in Philadelphia in 1914." These papers teem with specific instances illustrative of the peculiarities of the antivivisectionists, many of them dealing with the classical, oft-quoted examples of supposed barbarities of the experimenters. To any one who has read of these and who supposes them to be as charged in the indictment, the reading of the present book is highly recommended, for it shows how often and how wickedly the truth has been perverted for partisan purposes. Dr. Keen handles without gloves the opponents of scientific progress.

No one, in America at least, has been more roundly denounced by them, yet this denunciation, it may be mentioned incidentally, results in making him all the more cheerful. No earnest and unprejudiced seeker after the truth can turn from the perusal of this book without a feeling of disgust at the iniquitous kind of warfare that has been waged by the enemies of progress and without a keen recognition of the utter feebleness of their attitude. In relentlessly exposing them Dr. Keen deserves the gratitude of all men and women who love truth and humanity.

FREDERIC S. LEE

COLUMBIA UNIVERSITY

An Introduction to the Study of Physical Metallurgy. By WALTER ROSENHAIN, B.A., D.Sc., F.R.S. New York: Van Nostrand Company. 390 pages, 6 × 9. Illustrated. Net $3.50.

The book is divided into two parts, the first section dealing with the structure and constitution of metals and alloys, the second with the properties of metals as related to their structure and constitution.

Taking up first of all the microscopic examination of metals, the author discusses the preparation of specimens, and the microscope used, then the microstructure of pure metals and alloys. This is followed by the thermal study of metals and alloys, the thermal diagram and its relation to the physical properties. Typical alloy systems are exemplified by the lead-antimony, lead-tin, zinc-aluminium, zinc-copper, tin-copper and certain ternary alloys, followed by the iron-carbon system.

The second part first reviews the mechanical testing of metals, the effect of strain on the structure, heat treatment, mechanical treatment and casting, and ends with a discussion of defects and failures.

To review the contents of this book thoroughly would take many pages, because the author has covered the broad field of metallography so thoroughly and so well. This is particularly true of the presentation of the comparatively new ideas on the structure of metals, the effects of strain and of annealing, developed from Beilby's amorphous metal theory. The elongation of the crystals when strained, the production of slip-bands and their nature, the formation of amorphous layers and the hardening of metals by cold work, twin structure, fracture under tensile, shock and alternating stress conditions, the amorphous cement theory, are all most clearly set forth. The criticisms therefore must be on minor points and not on the broad lines of the book.

For example, on page 13, after mentioning the names of the earlier workers, Sorby, Martens, Osmond, Werth, Grenet, Charpy, Le Chatelier, Heyn, Wüst, Tammann, Andrews, Arnold, Roberts-Austen, Stead, Howe and Sauveur, the author says: "The fact that the present author was privileged to count Roberts-Austen and Osmond amongst his personal friends, and that Arnold and Stead are still actively at work in this field, serves to show how very recent the whole development has been." Besides Arnold and Stead, many of those mentioned are "still actively at work" as current literature in the metallographic field amply proves.

On page 21, in describing the preparation of specimens for polishing, "the necessity of gripping the specimen in the vise" to file it is mentioned. Most people grip the file in the vise and rub the surface of the specimen on it.

On page 31, the reference to etching reagents is too short and might with advantage be expanded.

On page 162, as Ruff's work is mentioned, reference ought also be made to that of Wittorf and of Hanemann.

The photomicrographs are all well chosen and excellently executed, but lose somewhat in not having a title beneath each, rather than in the list of plates.

In conclusion, the only change that could be suggested is in the section on the thermal diagram which should contain those diagrams showing partial solubility in the liquid state. A short classification according to solubility in both liquid solid states would help.

The author has succeeded in preparing an excellent book, interesting to the student, valuable to the metallurgist and engineer, and full of ideas for any one engaged in metallographic research. It is a book that can be

recommended to the general reader also, because the style is simple and the ideas are clearly and logically developed and followed. With the growing interest in metallography as a method of testing and of research it will undoubtedly prove very popular.

W. Campbell

SPECIAL ARTICLES

THE TEMPORAL FOSSÆ OF VERTEBRATES IN RELATION TO THE JAW MUSCLES

About two years ago one of us (Gregory) discovered that the superior and lateral temporal fenestræ of all two-arched reptiles and the single fenestra of all one-arched reptiles appear to be related to the jaw muscles in such a way that they either give exit to them upon the top of the skull or afford room for them at the sides. It was afterward learned that Dollo[1] had reached the same conclusion in 1884, but his important results have been practically ignored in the subsequent literature of the temporal fenestræ, which have been considered too largely from a purely taxonomic viewpoint and too little with reference to their adaptational significance.[2]

More in detail, the steps leading to the present note were chiefly as follows:

It was observed that the temporal fossæ of *Cynognathus* and other Theriodonts present close resemblances to those of primitive mammals and it thus seemed highly probable that in these reptiles the sagittal and occipital crests, together with the zygomatic and postorbital borders, bounded the homologue of the mammalian temporalis muscle. Comparison with the snapping turtle *Chelydra* suggested that in this case also the backwardly prolonged sagittal crest served for the attachment of the temporalis; and this gave added significance to the immense temporal fossæ and massive mandible of *Chelone*. The partial excavation of the dorsal roof over the temporal muscles in *Chelydra* appeared to give this muscle more room for action, and the almost complete removal of the temporal roof in *Trionyx* seemed to give further evidence in the same direction.

In *Sphenodon* it was seen that the borders of the superior temporal fenestræ apparently served for muscle attachment, and dissection of a specimen of this animal showed that this inference was correct, and that the lateral temporal fenestræ gave room for the expansion and contraction of the voluminous muscle mass. It was further recalled that in the most primitive Tetrapoda (stegocephalians and cotylosaurs) as well as in primitive Osteichthyes (*Polypterus,* Devonian Rhipidistia, Dipnoi, etc.) the temporal region is completely roofed over, while modernized forms such as Urodeles, Anura, lizards and snakes have the outer temporal roof reduced to slender bars or even entirely absent. The presence of a sagittal crest in *Amphiuma* indicated that in the modernized Urodeles the temporal muscles had extended on to the top of the skull. From such observations the following inferences were drawn:

1. That in primitive vertebrates the chief temporal muscle-mass (adductor mandibulæ of sharks) was originally covered by the dermal temporal skull-roof.

2. That in modernized Amphibia and Reptilia, as well as in birds and mammals, one or more slips of the primitive adductor mass had secured additional room for expansion by perforating the temporal roof either at the top or at the sides or in both regions at once; much as in hystricomorph rodents a slip of the masseter has invaded the region of the infraorbital foramen, so that it now extends through a widely open arcade and finds room for expansion on the side of the face.

3. A comparative study of the skull of *Tyrannosaurus,*[3] in connection with the above-mentioned observations and conclusions, led to the suspicion that the antorbital fenestræ of

[1] "Les Muscles éleveurs de la Mandibule et leur Influence sur la Forme du Crâne: Cinquième Note sur les Dinosauriens de Bernissart," *Bull. Mus. Roy. Hist. Nat. Belg.,* Tome III., 1884, pp. 136–146.

[2] A partial exception to this statement is afforded by Professor Lull's well-studied reconstruction of the cranial musculature of *Triceratops* (*Amer. Jour. Sci.,* Vol. XXV., 1908, pp. 387–99).

[3] Partly embodied in Professor Osborn's memoir on *Tyrannosaurus, Mem. Amer. Mus. Nat. Hist.,* N. S., 1912, Vol. I., Pt. I.

dinosaurs, phytosaurs, pterosaurs, etc., were also functionally connected with the muscles of mastication; but it was realized that proof of this view required a wider study of the jaw muscles of living reptiles. It was afterward found that Dollo (1884) had suggested that the antorbital fenestræ of extinct reptiles were filled by the pterygoid muscles.

4. With regard to the supposed relations of the mammals with the Theriodont reptiles, it was thought that some light on the origin of the mammalian alisphenoid and pterygoid and on the probable steps in the transformation of the reptilian into the mammalian condition could be obtained by a study of the muscles of the pterygoid region in existing reptiles and mammals.

5. The supposed transformation of the reptilian quadrate, articular and angular, into the mammalian incus, malleus and tympanic, respectively, as held especially by Gaupp,[4] Gregory,[5] Broom[6] and Watson,[7] might, it was thought, be further elucidated by a careful reconstruction of the jaw muscles of *Cynognathus* and by a study of the muscles of the middle ear in mammals (m. stapedius, m. tensor tympani).

6. In directing the studies of graduate students upon the structural and phylogenetic history of the skull in vertebrates it was found advantageous to emphasize the functional meaning and importance of the chief openings in the skull, and to consider the osseous elements in the temporal and pterygoid regions as if they were mere remnants, or tracts of bone, resulting from the reduction of an originally continuous dermal covering, through the moulding influences of the jaw muscles.

7. In comparing the skull patterns of the oldest Osteichthyan fishes (Dipnoi, Rhipidistia, etc.) sutures came to be regarded as loci of movement or progressive overgrowth, conditioned in part by muscular action, while centers of ossification were considered as loci of relative stability.

At this point the junior author of the present note undertook to make a broad and at the same time sufficiently detailed study of the jaw muscles of vertebrates, partly with the view of testing and extending the foregoing observations and conclusions.

It was soon found that while many anatomists had made intensive studies of the innervation of the muscles of mastication in certain types very few had attempted to follow them throughout the vertebrates and no one had given an adequate series of figures. It is indeed a surprising fact that comparative myology is so briefly treated in the standard textbooks. The work has been carried on in the laboratory of vertebrate evolution in the American Museum of Natural History. A series of 26 existing types of vertebrates has been studied and figured as follows: Elasmobranchii 1, Chondrostei 2, Holostei 1, Teleostei 3, Crossopterygii 1, Dipnoi 1, Urodela 3, Anura 1, Chelonia 1, Rhynchocephalia 1, Lacertilia 2, Crocodilia 1, Aves 1, Mammalia 7. In each case special attention has been paid to the innervation of the muscles as a guide to homologies. By means of these data, and of the principles that became apparent as the work proceeded, reconstructions of the jaw musculature were attempted in the following series of extinct forms: *Dinichthys* (Arthrodira), *Eryops* (Temnospondyli), *Labidosaurus* (Cotylosauria), *Cynognathus* (Cynodontiæ), *Tyrannosaurus* (Theropoda). The full results of this study will be published elsewhere by Adams, but meanwhile it may be worth while to record the chief general conclusions which we have reached in collaboration.

1. It seems impossible to work out the jaw musculature of *Dinichthys* either on the dipnoan or on the ordinary teleostome bases and a study of the muscle areas by Adams indicates a unique type of jaw movements, a fact of no little phylogenetic significance, in view of the disputed relationships of this group.

2. The above mentioned conclusions of Dollo and of Gregory regarding the origin of

[4] "Die Reichertsche Theorie," *Archiv. für Anat. und Entw.*, Supplement Band, 1913.

[5] *Bull. Amer. Mus. Nat. His.*, Vol. XXVII., 1910, pp. 125–143; *Jour. Morph.*, Vol. XXIV., 1913, pp. 23–35.

[6] *Proc. Zool. Soc.*, 1912, pp. 419–25.

[7] *Proc. Zool. Soc.*, 1914, pp. 779–85.

the temporal and antorbital fenestræ of reptiles are reinforced by much additional evidence.

3. The inferred conditions of the jaw musculature of *Cynognathus* are entirely in harmony with the views (*a*) that in the mammal the back part of the reptilian jaw became transformed into the accessory auditory ossicles; (*b*) that the basal portion of the mammalian alisphenoid is homologous with the reptilian pterygoid as suggested by Watson,[8] while the ascending portion seems to have been derived from the epipterygoid, as held by Broom and Watson.

4. In the transitional pro-mammals the reptilian pterygoid muscles pterygoideus anterior) became greatly reduced in correlation with the reduction of the elements behind the dentary; a possible vestige of these muscles may be the tensor tympani muscle, which runs from the basicranial region to the handle of the malleus. The mammalian internal and external pterygoid muscles are only partly homologous with those of existing reptiles and represent slips of the capiti-mandibularis mass, developed as the new joint between dentary and squamosal became established. The loss of the descending flange of the reptilian pterygoid, the secondary separation of the pterygoids along the mid-line and the transformation of the reptilian transpalatine into the true mammalian pterygoid (as held by Watson) all become more intelligible when considered in connection with the above-described changes in the musculature.

5. As a working hypothesis it is assumed that the transformation of certain elements in the temporal and occipital regions of early Tetrapoda was partly conditioned by the stresses induced upon the skull roof by the jaw and neck muscles. Comparison with lizards, *Sphenodon*, etc., clearly indicates that the prolongation of the parietal into a postero-external process joining the true squamosal was correlated with the squeezing effect of the capiti-mandibularis and depressor mandibulæ muscles. This may also be responsible for the appression and coalescence of the superior and lateral temporal elements (supratemporal and squamosal), in the early reptiles. The shifting of the post-parietals (dermo-supraoccipitals) and tabularia from the dorsal to the posterior aspect of the occiput was no doubt influenced also by the forward growth of the neck muscles upon the occiput.

[8] *Ann. Mag. Nat. Hist.* (8), Vol. VIII., Sept., 1911, pp. 322–23.

W. K. Gregory,
L. A. Adams
American Museum of Natural History

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE
SECTION D—MECHANICAL SCIENCE AND ENGINEERING

The first session was held in the morning of Wednesday, December 30, in the engineering building, Vice-president Frederick W. Taylor and Dr. Charles S. Howe in the chair, with an attendance of about 130. It was announced that the sectional committee had recommended for election to the general committee for the office of *Vice-president*, Dr. Bion J. Arnold, of Chicago. The following officers were elected by the section:

Member of Council—Dr. Rudolph Hering, of New York City.

Member of General Committee—Morris L. Cooke, of Philadelphia.

Member of Sectional Committee—Dr. Charles S. Howe, of the Case School of Applied Science.

The program of the session was as follows:

Principles of Scientific Management: Dr. Frederick W. Taylor.

Which is to Control Public Works—a Board or a Single Head?: Morris L. Cooke.

The Improvement and Enlargement of Transportation Facilities: George S. Webster.

A Study in Cleaning Philadelphia's City Hall: William H. Ball.

Every city, town and hamlet which owns a public building of any kind is confronted with the problem of efficient and economical cleaning. Public buildings are constantly growing in size and it is becoming more and more possible to handle the problems of their maintenance and operation on a technical basis. The fact that after what must be admitted to have been a crude study, extending over only a few months, we were able to effect economies amounting to over $30,000 a year, or $100 a day, in the cleaning of one public building, shows the possibilities. According to technical and other literature the cleaning of public buildings has been given very little

consideration, particularly from an engineering standpoint.

We must look to the development in this field of definite standards as to both appliances and methods. This standardization must be of such a character as to be applicable wherever work of this kind is done. Most of our present appliances and materials are crude and the outgrowth of almost no study that could be called scientific. While there are undoubtedly inherent difficulties in handling the personnel on the same basis that they are handled in industrial establishments, improvement in this direction has been so rapid in the last few years that we have every reason to look forward to further radical improvements in this direction.

It should be pointed out that there are no inherent differences between the cleaning of private buildings. Therefore, in looking at the whole problem of cleaning buildings, and judged by what it means both in dollars and cents and in the comfort of the occupants, the problem is a proper one for engineering attack and solution.

Experience in Locating and Mapping Pipes and Valves in an Old Water Works System: Carleton E. Davis.

The necessity for complete plans and records of pipes and valves in a water-works system is evident. In many cities, too much dependence has been placed upon the memory of employees and too little stress has been laid upon the importance of accurate and enlightening records so distributed as to be immediately available by as many employees as possible.

In the definite scheme of obtaining and recording such information, much spare time of employees can be used in obtaining data without adding to the general expense. The city of Philadelphia is operating such a system with reasonable success.

New Water Supply Conduit of the City of Hartford Water Works: Caleb Mills Saville.

The development of a new water supply for the city of Hartford, Conn. (pop. 131,000 in 1914), comprises a collecting and storage reservoir, located 14 miles from the city, with a capacity of 9 billion gallons; a compensating reservoir of 3 billion gallons to compensate mill owners for the stream flow taken for the collecting reservoir; a pipe line, conduit and tunnel from the collecting reservoir to one of the existing distributing reservoirs; a filtration plant and a large size main supply line from the distributing reservoir to the city.

This paper tells in detail of the construction of the 3,667 feet of concrete conduit, 2,333 feet of concrete lined tunnel, and 39,660 feet of 42-in. cast iron pipe line. The conduit is of horseshoe section, cut and cover type 5 ft. × 4.75 ft. vertical and horizontal dimensions. Some excavation as deep as 30 feet in the overlying glacial drift was necessary. The construction of the tunnel was preceded by complete diamond drill borings. The geological structure encountered was a basalt lava flow overlying the Connecticut red sandstone.

The construction of the 42-inch cast iron pipe line 7½ miles long is fully described. The canvass of the bids is given, and an unusual way of discriminating between bids for furnishing steel and cast iron pipe, whereby 15 per cent. was added to all bids received for steel pipe.

Latest Advances in Inoffensive Sewage Disposal: Rudolph Hering.

The paper covered the latest advances made towards obtaining an inoffensive collection and disposal of sewage, which has now reached practically satisfactory solutions for nearly all possible cases.

The chief means to prevent all foul odors in the collection of sewage are to maintain (1) a continuous flow and no deposits and retentions of sewage, (2) a frequent flushing and (3) a free air circulation in all sewers.

A large number of sewer systems with these means now continuously deliver an inoffensive sewage.

The means for an inoffensive final disposal of sewage depend on the local possibilities. In nearly all cases the solids and liquids require separate treatment.

1. In sufficiently large masses of flowing water. The liquids can be dispersed in them in well known proportions so that no offense is possible and so that automatic oxidation of organic matter takes place. The solids can be retained and, according to their quantity and character, can be treated economically and inoffensively in efficient ways.

2. On land. The liquids must be oxidized by sufficiently extensive thin film surface contact with bacterial slime, as by percolation through sand, gravel or broken stone, the surfaces of the grains being well covered with slime, and well exposed to air circulation. The oxidation of all organic matter may thus be graded in degree and always be inoffensive.

The solids must be collected under water in tanks under conditions preventing putrefaction, but which cause a sufficient decomposition by bacteria producing chiefly methane gas and carbon dioxide, both inoffensive, and a final sludge re-

sembling humus soil in forests, also inoffensive. This has been made possible by the recent extensive introduction of Imhoff tanks. Quite recently it has been found that a daily mechanical agitation of the sludge and always maintaining its alkalinity, materially hastens the decomposition.

Operation and Efficiency Reports from Water and Sewage Purification Plants: RALPH E. IRWIN.

In Pennsylvania the state commissioner of health is required by law to give a permit for the construction of all water purification plants supplying water to the public for domestic purposes and for all municipal sewage treatment plants. To intelligently issue a permit for the construction of such plants it is necessary to have detailed information concerning the efficiency, manner of operation and construction of existing plants. The commissioner has, therefore, created a section in the engineering division which, under the direction of the chief engineer, inspects and tests plants already in operation.

Operation and efficiency reports should be submitted to the commissioner of health:

1. That the commissioner may know accurate records are being kept by each plant.
2. To give information for answering complaints from those served.
3. To assist in locating the cause of water-borne disease apparently due to public water supplies.
4. That information may be at hand from all parts of the state, thus forming a clearing house for information from plants treating similar waters or sewages and make it possible to indicate the most efficient and economical method of treatment when considering improvements, or the construction of new plants.
5. To allow checking results from one plant with another to show inaccuracies or carelessness.
6. To give information for interpreting results of analyses submitted by plants, those served, or results of samples analyzed at the commissioner's laboratory.
7. To give information upon which to base suggestions for the prevention of waste of chemicals, wash water, etc.
8. To assist in judging the efficiency of operators in charge of plants.
9. To have records at hand showing when inspections and tests are necessary and to assist in this work.

At the present time in Pennsylvania there are 115 water filtration plants and 91 sewage treatment plants in operation. Also, there are a large number of chemical dosing plants installed for the disinfection of dangerous water supplies and insufficiently treated sewage.

The New York Sewage Disposal Experiments and Plant at Brooklyn, N. Y.: GEORGE T. HAMMOND.

The experiment plant described in this paper was authorized by the Board of Estimate and Apportionment of the City of New York, $50,000 being provided to cover the cost. One of the most difficult sewage disposal problems which the city must solve is afforded by the rapidly progressing pollution of Jamaica Bay—a tidal reservoir 19.28 square miles in area and very shallow, the situation of an important oyster industry. The population contributing sewage to this bay is 250,000 persons, of whom 210,000 are in Brooklyn. The sewers are on the combined plan and discharge 18,000,000 to 22,000,000 gallons of dry-weather flow into the bay daily. Storm-water flow from the sewers at times reaches over 1,000 cubic feet per second and is very foul. One of the principal purposes of the experimental plant is to find the best means of treating this sewage.

The plan of the experimental plant provides for pumping the sewage to an elevated supply tank, from which it is fed by gravity to the experimental units. The amount of sewage used by the plant is about 1,200,000 gallons per day. The experimental plant includes three Imhoff tanks of varying size and depth; six sprinkling filter beds; one tank-aerator for treatment of sewage with compressed air supplied by an air compressor; one siphon-aerator, which treats sewage by compressed air, which is supplied by the flowing stream of sewage through a hydraulic air compressor siphon; one gravel strainer, or roughing filter; four settling or sedimentation tanks; six secondary sedimentation tanks; ten sludge drying beds of the Imhoff type. Various types of screens, including a Riensch-Wurl screen. Various experiments are also provided for the disinfection of sewage effluents and for various methods of treating and disposing of sludge and screenings. All of the units of the plants are constructed on a working scale, each one large enough for testing the actual operation conditions of a full-size plant.

Some Considerations Affecting the Disposal of Sewage at Seaside Resorts: MARSHALL R. PUGH.

For a distance of approximately one hundred and twenty-five miles the coast of New Jersey has an almost continuous line of summer resorts, some large and some small. Some of the considerations theoretical and constructive, affecting the disposal of sewage at seaside resorts may be briefly stated as follows:

The Collecting System.—(1) Use self-cleansing velocities where possible, but do not be bound by them when they result in a cost incommensurate with their benefits. (2) When self-cleansing velocities can not be wisely adopted, make adequate provision for flushing. The sewers must be kept clean.

The Disposal Plant.—(1) The plant must be adapted to great seasonal variations in flow. (2) The capacity of the ocean to digest and purify the sewage, being the most economical and effective means of attaining this end, should be made use of. (3) Where bathing is an asset, the discharge of crude sewage to sea is not permissible. (4) Single-story tanks furnish in general the method best adapted to treating the sewage of resorts before its discharge to sea. (5) Nuisances from such effluent do not arise if tanks and appurtenances are correctly planned and the discharge effected through a properly designed outlet, at a sufficient distance from shore, and in ten feet or more of water. (6) It would appear from what evidence we now possess that no ill effects to health result from the proper discharge of such effluent. (7) Owing to the difficulties encountered in work along the coast and under the surface of the ocean, careful consideration must be given to durability and to the means of executing the work called for by the plans.

Preservation of Wood: P. A. Maignen.

The railroads are said to spend $121,500,000 a year in cross ties. If all these ties were treated properly by a good preservative process, it would be possible to save more than $450,000,000 in 25 years. Wood is composed of two principal parts, cellulose and sap. Cellulose resists decay a long time. The decay begins in the sap and extends to the cellulose. It is therefore urged that some ways and means of removing the sap from the wood be found. Many attempts have been made to render the sap proof against decay without removing it, but the result has not been satisfactory.

The preservatives used in the United States in 1913 were: 108,373,359 gallons of creosote; 26,466,803 pounds of zinc chloride, and 3,885,758 gallons of other preservatives. In that same year there were 153,613,888 cubic feet of timber treated by all preservatives. Of the creosote used only 38 per cent. was produced in this country and 62 per cent. was imported.

At present 30 per cent. of the railroad ties are treated. If a satisfactory method of impregnation could be devised so that the wood could get the full benefit of a thorough penetration it would not be long before all the ties would be treated. Unfortunately the impregnation, as carried out now, does not penetrate the wood sufficiently. In experiments it was found that one specimen from which the sap had been removed was impregnated throughout the whole length of the wood; whilst the other specimen of the same kind, but whose resins had not been extracted, was impregnated not more than a few inches from each end.

The second session was held on the afternoon of Wednesday, December 30, Vice-president Dr. Frederick W. Taylor and Mr. O. P. Hood in the chair, with an attendance of about 95. The program of the session was as follows:

Municipal Highways—a Problem in Maintenance: William H. Connell.

The three foremost problems involved in the operations of a highway department are: Organization, maintenance and construction.

A good organization is essential particularly in so far as maintenance is concerned, as it is practically impossible to continuously and systematically maintain pavements and roads in first-class condition, in an economical manner, without a good working organization built up along the lines best adapted to cope with the conditions involved in this important branch of work coming under the jurisdiction of a highway department. By this it is not intended to give the impression that the maintenance organization should be separated from the construction, as separate organizations are apt to result in an overlapping of jurisdiction and a tendency to shift responsibility, and open up a field for unlimited excuses as to whether the construction or maintenance division is responsible for any unsatisfactory conditions that may arise relative to the pavements. Furthermore, it is obvious that the logical organization to maintain the pavements is the one that saw them laid and is familiar with every detail of the construction, as very often a knowledge of apparently trivial conditions in connection with the construction bears an important part in the future maintenance.

Routine maintenance includes such work as the regular street cleaning in municipalities, and the cleaning of country roads and gutters, and any other work of this character that is more or less routine and should be performed under definite schedule. The streets in the thickly populated sections of the city should be cleaned every day; in less thickly populated sections, every other day; every third day, and so on until we come to the

country roads which should be cleaned once a week, once every two weeks and some only once a month, depending upon the amount and character of the traffic which largely governs the frequency with which the cleaning should be done. The amount and schedule of work and the force necessary to perform it can be determined upon in advance and carried on in a systematic manner under a regular organization, more or less military.

General maintenance includes repairs to streets and roads, and involves different characters of work, each requiring special knowledge on the part of those engaged in the actual performance of the physical work for which special gangs have to be organized. Stone block, wood block and brick repairs, for example, require skilled laborers who have made a specialty of this work and are employed under the title of pavers and rammers; while repairs to asphalt and bituminous pavements must be performed by men specially skilled in this line of work, in addition to the necessary force engaged at the mixing plants. Macadam road repairs, the care of earth roads, and bituminous surface treatments, also require men specially trained, and while it is desirable to train the gangs for each particular branch of this work, such, for example, as bituminous macadam built by the penetration method, water-bound macadam, bituminous surface treatments and the care of earth roads, the three classifications, namely, block repairs, bituminous pavement repairs (mixing method), and macadam, earth road and bituminous surface treatments, represent the three branches into which the organization is usually divided.

Methods for the Elimination of Politics from Administration of Highway Departments: LOGAN WALLER PAGE.

We have a system, if it may be called such, of public roads approximating 2,300,000 miles. The people as a public corporation are yearly consenting to the expenditure of about $200,000,000 in a haphazard endeavor to make this vast road investment pay. That it is a losing investment, conducted on lines directly opposed to those of the best managed private corporations, is an established fact. It is estimated by road experts who have made a careful study of the various phases of the road question, that the American people yearly lose at least $50,000,000, directly and indirectly, because of their careless supervision of these traffic facilities.

State supervision seems to be the first and most effective step toward obtaining satisfactory road conditions. But there are certain evils for which the people of the state should provide safeguards in planning their system of state road management: First, the appointment in each unit or subdivision of only that number of road officials necessary to do the definite duties required of each in that unit, and the necessity for distinct placing of responsibility for work done. Second, some arrangement should be made whereby the road officials shall give the roads continuous and systematic attention, instead of the existing irregular care, which has proved so costly in the long run. Third, the requirement of necessary qualifications which the road official must possess to discharge his duties efficiently. Fourth, the demand that wherever practicable the incumbent of any road office shall be appointed because of his qualifications, in this way avoiding election of those who may prove more able politicians than engineers. Fifth, road officials would best serve the people if the term of office were limited by merit, and not terminated at regular periods. Sixth, provision should be made for a careful study of traffic needs in the individual localities so that political considerations may not be the deciding factor in the location of road improvement, distributing of appropriations, and appointing of needed officials.

Illinois has recently made a notable advance toward centralizing road control, and the placing of men on merit, as each county engineer takes a competitive examination, and is made an assistant to the state highway engineer, thus providing correlation and centralized oversight. In fact, the whole trend of state participation has been toward placing a broader scope of duties and authority in the central state department. This continued trend, it is hoped, will be one of the main factors in solving the problem of supervision, while the intelligent application of the merit system in securing this skilled supervision in road work is the only promising method of eliminating politics from road administration.

Plant Inspection for Pavements: JULIUS ADLER.

It has been a recognized fact that the complete inspection of any engineering structure begins with the materials to be used in that structure, and it is safe to say that this statement applies with full force to street and roadway pavements, in which such a wide variety of materials is now being used, and in which the life of the structure depends so very largely upon the strength, durability and suitability of the materials in resisting the effects of traffic and the atmosphere. The fact, however, that so many uncertainties and diffi-

culties exist even to-day in regard to fixing the desirable qualities of many paving materials is a certain indication that this subject has not received the close study and systematic observation that its importance merits; furthermore, while there has been too great a tendency in some lines to charge all failures to the materials used, or some one of them, rather than to the methods of construction, it is also certain that a considerable proportion of failures in paving work can still be traced to the use of materials, which, if not actually of poor quality, were unsuitable for the conditions at hand.

The desirable scope of plant inspection must first be established before the actual duties and details can be determined. The work may be confined to the general inspection and sampling of materials and mixtures, requiring nothing more than that the contractor shall keep within the more or less broad limits of the specifications, but allowing him discretion and variations within these limits. Going a step beyond this idea, the inspection may be carried on as actual plant control, in which the highway organization assumes the right to specify narrower limits for a given piece of work as to amount of bitumen, hardness of the asphaltic cement, temperature of mixtures, and even to some extent the exact details of the method by which these mixtures are to be obtained. The latter plan, that is, plant control, is the logical one to follow on standard, if not patented pavements as well, from the standpoint that the organization which formulates the specifications should also be most capable of regulating their application.

Specifications Covering the Rolling of Road Crusts of Various Types: Major W. W. Crosby.

The assumption is made that the contract and specifications are to be in the more usual form under which the contractor is "to furnish all the labor and materials and do all the work."

Before proceeding to details, it seems necessary, for the sake of clearness, to state certain general principles in regard to specifications.

In the first place, while it may be necessary sometimes to restrict in details the methods to be followed, generally it will be found more satisfactory to specify the results to be obtained rather than one exact method for reaching the result. Elasticity for meeting variations in conditions encountered will then not be wanting. This is especially true as regards rolling.

Secondly: Where necessary the methods of producing the result may be limited by specific description but this should be done only when unavoidable for the insurance of proper results and for preventing the production of a result which will be offered for acceptance as "just as good."

Thirdly: For economic reasons as much elasticity in the provisions for limits, in the descriptions of the machinery or tools allowed for use, should be given as is practicable.

Fourthly: The specification of the result to be secured should be absolutely definite, clear, and as brief as may be consistent. The specification should so describe the product that no more room for argument as to the fulfillment of the specification will exist than will be occupied by a few questions whose answers can and must be determined by scientific methods, such as physical or chemical analyses and arithmetical calculations or measurements.

The author cites the following specification covering the rolling of the second course of a macadam road as embodying the fundamental principles cited.

Second Course

"After the metal for the second course shall have been spread to the proper thickness and cross-sections, it shall be rolled as hereinbefore provided under the head of 'First Course,' except that water, in connection with the rolling, shall be used as follows: When the rolling shall have been carried on to the point where the metal of the second course will not push or 'weave' ahead of the roller and any depressions or unevennesses have been properly remedied, as provided, the rolling shall be interrupted and a thin layer of sand, screenings or other approved binding material, shall be evenly spread over the surface of the second course metal with as little disturbance of the latter as possible. The quantity of fine material so applied shall be just sufficient to cover the metal and care shall be exercised to avoid its use in excess. Water shall then be sprinkled on the roadway surface and the rolling at the same time resumed, the quantity of water used being such as will prevent the fine material from sticking to the wheels of the roller. The combined watering and rolling shall be continued until the voids of the metal shall become so filled with the finer particles as to result in a wave of water being pushed along the roadway surface ahead of the roller wheel. The watering and rolling shall then be discontinued until the macadam shall have dried out. If then the metal shall begin to loosen and to appear on the roadway surface, or if the voids in the metal shall appear to

be not properly filled, the watering and rolling shall be resumed with the application of only as much additional fine material as may be necessary. Any depressions or unevennesses appearing during the above operations shall be remedied by the contractor as hereinbefore provided, and when completed the macadam shall be uniform, firm, compact and of at least the thickness required and shall have an even surface nowhere departing by more than one inch from the grade and cross sections shown on the plans.''

Life of Bond Issues for the Construction of State Highways: E. P. GOODRICH.

Financial Problems Involved in the Selection of a Suitable Type of Road or Pavement: JOSEPH H. CONZELMAN.

The most common methods of obtaining funds for highway improvements are: by general taxation, by special taxation, by assessments on those particularly benefited, by bond issues and by combinations of these methods. A large part of the work done by state highway departments is financed by appropriations from the general tax.

The paving work of many cities in the United States is paid for with money secured by assessing the abutting property. Some revenue is collected in this way in a few rural districts. Special assessments are not, however, very popular or just in these sparsely settled sections because of the large extent of abutting property owned by individuals, and the low property value. Where assessments are practicable and are paid immediately, this method is an economical means of financing highway improvements.

Bond issues have come into general use as a means of obtaining money for state and county highway work, where a large amount of construction is planned. They render large sums of money available for immediate use, making possible a large amount of improvement which probably could not otherwise be financed. Bonds have been issued, however, in many localities with little consideration of the principles of economics. Money obtained in this way has been used to build roads, parts of which, at least, have worn out long before the bonds issued were redeemable. In other instances no provision has been made for retiring the bonds.

Bonds issued for a period of years not greater than the life of the roads which are to be built, when proper provision is made to retire them, is certainly an economical method of obtaining money. The conditions in some parts of the country, for example, in the grain districts, would seem to justify the issuance of bonds whose term extended beyond the life of parts of the highways built, if money for the work could be raised in no other way. Where fifty-year bonds are used to finance the building of roads or pavements, the fairest method, to the present and future generations, of redeeming the bonds and providing for the necessary reconstruction during the life of the bond, is that method which distributes the cost of the improvement most evenly among those deriving the benefits. The method which will most closely accomplish this endeavor must provide for the determination of the life of the several parts of the improvement, and, on the basis of this determination, distribute the cost of the improvement.

Preliminary Surveys and Mapping of National Highways: CHARLES HENRY DAVIS.

A national highway must be interstate. They must be located along the line of densest population so they may carry the heaviest traffic. This is between the large cities and those lying between them on the center line of water sheds. Fifty thousand miles of such national highways will serve, in the counties through which they pass, 88 per cent. of the urban and 53 per cent. of the rural, or a total of 69 per cent. of the people of the United States. It is here that the greatest rural population and tonnage will be served the best, not by so-called radial roads from railroad stations or towns. If a system of 100,000 miles was built, such roads would carry so nearly the entire rural tonnage as to make the balance negligible. The data for locating such a system has been secured for the forty-eight states. Seventeen have been completed, engraved and printed. Five more are ready for engraving. Every named place on these highways will be shown, whether city, town, village, hamlet, post office or otherwise. Also adjacent communities are shown. These maps will be standard and will require but little revision to keep them accurately up-to-date. The scale is such that straightening or relocating a road between two places will not require alteration of the maps. If a traffic census were taken on the alignment of such a mileage we would gain conclusive evidence as to the correctness of the above statements and thus avoid costly and fatal errors. When completed these maps will occupy a volume 5 in. $\times$ 10 in. of only 100 pages (50 sheets 10 in. $\times$ 10 in.) which with 44 pages of index of every named place will only be ¼ in. thick, including maps and index. When compared with maps available at present their usefulness and convenience are at once apparent.

Construction of Highways with Convict Labor in West Virginia: A. D. Williams.

The labor of the prisoner should not be exploited for the profit of a few and to the detriment of the honest laborer, but in justice to the man in prison and to society the prisoner should be given some useful and beneficial employment. This employment should be of such a nature as to give back to society in a measure atonement for the debt of transgressing society's laws, so that the prisoner will feel that he has rendered a just compensation for his own acts. The labor should be of such a class as would render the broadest service to all of the people, and not infringe upon the rights of any free laborer any more than possible. But the free laborer should not ask that society support an idle prison population so that he might monopolize all the work. The free laborer has as much right to ask a pension, and would do society much less harm in procuring a pension than in compelling the support of an idle criminal population which will turn on to society a weakened bunch of men. The prisoner for his own good must be employed. This labor should be given upon some class of property or the improvement of some class of property held in common by all the people. Therefore, improvement upon the public roads is a class of development that benefits everybody. This is public property, improved for public advancement, and the prisoner being a public charge can here be justly used for the public's good.

The great good that can come to the public from the use of any prisoner or prisoners is not his labor, but is the improvement of the individual by making of him a useful and beneficial citizen. An investigation on the part of the writer reveals that men or prisoners worked in the open air under a system wherein appeals can be made to the better manhood in their natures make better citizens than those employed in confinement.

West Virginia has a law which provides that the prisoner may elect to labor prior to his trial in case he is denied bail and is unable to give bond. This is a humane step and offers an opportunity for the man who has been wrongly accused to keep up his muscles and to provide in a measure for his family while being detained. The law at the present only permits payment of 50 cents per day if released or gives a credit of $1.00 per day on fine if convicted. The writer believes that this should be made a credit of $1.00 in case of release. The writer further believes that prisoners who work upon their honor and give good service should receive a wage which should be retained until the expiration of the sentence or in case of needy families be given to them. Because a man has transgressed a law and is deprived of his liberty is no reason why he should not retain his responsibility to his family and society should give him this privilege because oftentimes the innocent wife and children are punished more than the man in prison.

Utilization of Short-term Convicts for Highway Work in Georgia: James L. Stanford.

To secure accurate data to form a basis for the investigation of road work for misdemeanant convicts, a questionnaire was prepared and sent to every county in Georgia and the results obtained are presented in a condensed form in this preliminary report.

The State Prison Commission reports that practically all of the misdemeanant and felony convicts, with the exception of the women and those in poor health, are employed in some phase of highway work; 2,441 misdemeanant and 2,740 felony convicts were worked by 124 counties during 1914.

Regardless of the kind of work undertaken by a convict gang, the following factors will be involved, the usual interest on the first cost and depreciation of the equipment of the annual expense of maintaining the convicts. The economical solution is to so adjust the size of road gang as to render the sum of these factors a minimum.

According to reports received and actual experience, which may be said to have passed the experimental stage, a guard can most economically and advantageously handle fifteen men. The number of units composing a gang should be proportionately determined by such factors as the expense per man, mileage of roads to be constructed and repaired, the character of the work to be done, the class of men in the gang, and the equipment provided. The expense per man both as to food and guarding at night increases rapidly as the number of men in a gang falls below thirty and decreases just as rapidly as the gang increases by units up to a certain limit. One night guard can handle a camp of ninety convicts quite easily since the day guards sleep near by and are ready to give him assistance at any time. The guards act as road foremen, hence the expense of employing foremen is obviated and balanced by guard hire. The guards should be hired at a stipulated amount and their wages gradually raised as they become more efficient foremen.

Arthur H. Blanchard,
Secretary

(*To be continued*)